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J D Nesbitt Esq

THE
Horſe-Hoeing Husbandry:
OR, AN
ESSAY
On the PRINCIPLES of
TILLAGE and VEGETATION.

Wherein is ſhewn
A METHOD of introducing a Sort of
Vineyard-Culture into the Corn-Fields,
In order to
Increaſe their Product, and diminiſh the common
Expence;
By the Uſe of
INSTRUMENTS deſcribed in CUTS.

By *Iethro Tull*, Eſq;

Approved of and Recommended by the
DUBLIN SOCIETY.

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THE PREFACE.

I *THINK it unneceſſary (if not impertinent) to trouble the Reader with a* long *Account of a* ſhort *Treatiſe, which he has before him: I might, as a Ruſtick, omit the Ceremony of a Preface, were it not reaſonable to expect, that an Apology will be required for writing and publiſhing a Book without the uſual Qualifications of an Author. It was not, indeed, my own Inclinations that prompted me to write; for (tho' almoſt all my Life has been a continued Sickneſs) I was ſo far from being inclined to the* Scribbling Diſeaſe, *that I had diſuſed Writing for above twenty Years, before I was prevail'd on to commit my Thoughts upon Husbandry, and the Deſcriptions of my Engines to Paper. The Solicitations by Letters which I can produce (enough to make an ordinary Volume) from Perſons of Rank, who had ſeen my Manner of planting* St. Foin, *&c. I could not abſolutely refuſe, notwithſtanding the many juſt Excuſes I made for declining a Task of* *which I knew myſelf incapable: A long Confinement within the Limits of a lonely Farm in a Country where I am a Stranger, having debarred me from all Converſation, except of* low Life, *I foreſaw that Words would be wanting to expreſs my Thoughts properly, which is a Misfortune that cannot be concealed: However at firſt I did not think I ſhould have had Occaſion of many, intending to write no more* Theory, *than my Notion of the* Paſture *of* Plants, *and to ſhew how their Roots are naturally adapted to receive the Benefit of the* Hoing *Husbandry, believing that the Whole of That might have been compriz'd in a Sheet or two, and the reſt in about as many more; but Books of Agriculture by chance coming to my Hands (I never having read any of them before) occaſioned more Writing than I propoſed.*

'Tis no Wonder that the Stile *is* low *as the Author, or the Duſt that is here treated of, ſince the Whole was written in Pains of the* Stone, *and other Diſeaſes as incurable, and almoſt as* cruel: *But fine Language will not fill a Farmer's Barn; neither does Truth need any Embelliſhments of Art.*

Connexion cannot be expected in a Book compoſed of Notes written at different Times, ſome in one Year, ſome in others, as ſomething new flow'd from a different Practice from what was common. Beſides, as I was by Sickneſs incapable of aſſiſting when it was tranſcribed for the Preſs, when many Notes were to be inſerted, my Scribe not underſtanding their Marks, miſplaced many of them, ſome in the Text, ſome in the Margin, ſome in the wrong Chapters, many he left out, and more being miſlaid which he did not find; among which laſt were the ſeveral Weighings of my drill'd Crops and the neighbouring ſown Crops: As for theſe and much of the ſpeculative Parts left out, if it had been more, it had been no great Matter; but as ſome of the Chap. *of Wheat is omitted, I ſhall rather inſert what of it is neceſſary into the Preface, than that the Beginner ſhall want it.*

Several Things cauſ'd the Want of Method. My Scribe was ſo little ſkill'd in Country Affairs as ſometimes to ſet the Cart before the Horſe, *as he does, where he places the Hoeing of Turneps before the Planting of them: But I preſume this Miſtake will not be followed by any Practiſer, and then Nobody will be injur'd by it, or by any other ſuch like* Hyſteron-Proteron *to be found in the* Chap. *of Wheat, or elſewhere in the Book: Another Injury to the Method was the five Chapters of the* Specimen *being taken out of their Places, and it not being timely reſolv'd whether they ſhould be reprinted or not, they were added after the other fifteen Chapters without ſeparating them.*

Some Things may be properly repeated, *where uſed in different Places for different* Purpoſes; *but I doubt this will not excuſe every Repetition the Reader will find.*

I had no Opportunity of correcting the Sheets from the Preſs, nor any Friend to do it for me, which might have been ſome Excuſe for the Faults of the Printer, had he not uſurp'd a Prerogative of Coining of Words: All he can pretend to ſay for his, and what I am ſure I can truly ſay for my own Faults (which perhaps may be more) is that none of them are wilful.

As to the Manner of filling the Pages with Notes, whether it be a Fault or not may be doubtful; thoſe who read *merely for Curioſity may blame it for being out of the* Mode; *but the Reader who intends to practiſe may like it the better; becauſe by this means Things are brought into the ſhorteſt Compaſs, and he has in his View in one Page as much Matter, as might be extended to ſeveral Sheets by the Introductory Words which would be neceſſary to carry it on in a* continued Diſcourſe: *If any one ſhall be ſo cenſorious as to ſay, I uſe this contracting Method, rather to ſave my own Time in Writing, than his in Reading, perhaps his Suſpicion may not be very unjuſt; for he who practiſes Agricul-*

ture with Effect, can have little Time to ſpare for either. Beſides, ſince I cannot pretend to ſay of this Treatiſe (as a late Authr ſays of his of much greater Bulk on the ſame Subject) that it is Multum in Parvo; *I may hope in reſpect of its Shortneſs, that it is not* Parvum in Multo; *and that Brevity may make a dull Diſcourſe* tolerable.

I beg Pardon of the Learned Writers from whom I am forc'd to differ *in Opinion, as well as in Learning; I aſſure them 'tis unwillingly and with regret that I do. No* Canon *having limited what we ſhall* think *in* Agriculture, *nor coudemned any of its* Tenets *for* Hereſy, *every Man is therein a* Free-Thinker, *and muſt think according to the Dictates of his own Reaſon, whether he* will *or* no: *And ſuch Freedom is given now-a-days in Speculations in* Natural Philoſophy, *that 'tis common to ſee People even in print maintain that there are* Antipodes, *that the Earth moves round the Sun, and that he does not ſet in the Sea, without being cenſur'd for theſe and many other formerly* Heterodox O*pinions: And any one may now upon* ſolid *Arguments contradict* Ariſtotle *himſelf publickly any where, except in the* Schools: *But that mine are ſuch, which I bring for maintaining the* Principles *I have advanced, I dare not affirm, being my ſelf no competent Judge of them, as the Reader (eſpecially the practiſing Reader) is; to his Deciſion muſt be left all that is diſputable; his Partiality I have no Reaſon to apprehend, becauſe 'tis in ſome Degree the Intereſt of every one who lives by Bread, that* true Principles *be eſtabliſhed in Agriculture; but none ought to be allowed as ſuch, 'till they have been thoroughly examined: Truth is like Gold, which the more it is tried the brighter it appears, being freed from Droſs. To be thus examin'd is the chief Deſign of publiſhing this Eſſay on* Tillage *and* Vegetation: *And ſince great Men ſeem to have made ſome Miſtakes of Conſequence in theſe Matters, it may well be ſuppoſed that I* *may have made many more; but of ſuch of theſe as ſhall be adjudged to be of* Subſtance, *no Man ſhall be more willing than myſelf, to ſign their* Condemnation; *and I believe the judicious Reader will excuſe ſuch Miſtakes as are merely of* Form: *His Candour will be alſo neceſſary for explaining ſome Things wherein a Miſtake may ariſe from their being improperly expreſs'd, and ſuch he will conſtrue as near as he can according to their intended Meaning, and when by that Misfortune they may ſeem to* jar *in one Part, he will endeavour to reconcile them by ſome other Part, or by the Tenor of the Whole.*

Every Man is beſt ſatisfy'd with Experiments made by himſelf; therefore I adviſe him who intends to practiſe, that he would repeat the Trials of all mine before he relies upon them; not that I have been unfaithful in the Making or Relating any of them (for I only made them in Search of the Truth for my own Satisfaction;) nor doubt I but that, if he follows the ſame Proceſs, *his will ſucceed as mine did, and he may very likely draw many more* Inferences *from them, than I have.*

The Experiment of artificially pulverized Earth ſeeming to confirm what I had writ of the Paſture *of* Plants, *I could not forbear inſerting it into my* Chap. *of* Tillage *as ſoon as I had read it; but Mr.* Evelyn *takes no Notice, that the* Surfaces *of thoſe* fine *Parts, into which the Earth is* divided *by ſuch* Pulveration, *is the* vegetable Paſture; *but runs into a* Simile *which would better fit the Climate of the* Indian Plants, *than* ours; *therefore I omit his* Theory, *leſt it ſhould offend the Modeſty of the Ladies produc'd in a* chaſter *Climate, if my Book ſhould chance to have the Honour of their Peruſal.*

I have ſometimes, for Brevity's ſake, produc'd only one Inſtance inſtead of many which I could have given; I know that a ſingle Inſtance is not ſufficient of itſelf, where there is no other Peoof; but when a Thing is firſt fully proved in Theory, *I think one Inſtance of* Fact *in* Practice *may be ſufficient for its Confirmation; and beſides,*

ſides, the Practiſer will be abundantly furniſhed with Inſtances from his own Experience.

The Matters of Fact *I have related, are not like ſome Stories told by* Travellers, *hard to be diſproved if they are wrong.*

I am in ſome Doubt concerning the Height of the Great Muſtard Plant; *becauſe I did not meaſure it, but by the* Idea *I had of it four or five Years after I ſaw it: It came accidentally on the Side of a Row of* Horſe-Hoed Peaſe; *'twas in moiſt Land that had been well till'd and dunged: This being the firſt of the Species that I had ſeen in this Country, and having formerly taken half a Pint of Seed from one ſingle Plant of it in* Oxfordſhire, *which was leſs then one lateral Branch of this, I deſigned to meaſure the Seed it would produce; but unluckily the People who cut the* Peaſe, *chopp'd it to Pieces with their* Hooks, *becauſe it did ſpread very wide and ſtood in their Way; the* Seed *not being ripe I was diſappointed in that; I might indeed have laid its Parts together and taken its Heighth, if I had then had any Thoughts of Writing, as I had not.*

This laſt Summer *I ſaw the Produce of two* St. Foin *Plants carefully weighed; they grew both in the ſame Ground, not far aſunder, and of the ſame Age* (viz. *ſeven Years;) the one ſtood ſingle, and its Product weighed thirty ſeven Ounces and an Half; the other grew in a Bunch among many Neighbours, and was dug up, and its Product cut cloſe to the Root weighed three Grains, which is about a five thouſandth Part of the other. I think this proves that 'tis not extravagant to* ſay, *that one* ſingle *(or thin)* St. Foin-Plant *may produce as much Graſs or Hay as a thouſand* thick *ones. And I have ſeen much* greater ſingle St. Foin-Plants *than this.*

As to the Diſtances of Rows, and other Matters of Practice, I could only tell the Beginner what I have done, *and the Reaſons (as far as a weak Memory, and* *my Notes ſerv'd me) whereon I proceeded; if he approves of them, they become his own, and he will proceed upon them as ſuch; or if he doubts, it cannot coſt much to ſatisfy himſelf by proper Trials.*

I have had great Crops of Turneps *in Rows three Foot aſunder, and much greater than I could ever obtain from Rows thirty Inches aſunder; but one Reaſon why I like ſix Foot Rows better is, that the largeſt* Turneps *are beſt for* Oxen, *and are pulled up and loaded with the leaſt Expence; for if they ſhould be as ſmall as the ſown* Turneps *hereabouts commonly are, that Expence would go a great Way into their Value. I find that the leaſt competent Number will* (cæteris paribus) *always be the largeſt; but here is a great Inconvenience happens to* theſe *(eſpecially when the ſown* Turneps *generally fail, as they do this Year)* viz. *as ſoon as they begin to head, the lawleſs People begin upon them, and the Roots being then covered in the Ground, they cannot eaſily know which of them they* like *until they have pulled them up, and ſo perhaps ſpoil ten for one that they take; but when the* Turneps *are grown as big as* Apples, *they make leſs Waſte, and carry away as many in a Bag, as (if they were ſuffer'd to attain their full Bigneſs) would load a Waggon. Thus is the beſt Crop ſooneſt deſtroy'd. I confeſs this is an Objection, to which I can give no effectual Anſwer, except this, that in a plentiful Year, when the ſown* Turneps ſtand, *their ſlow Growth renders them much ſweeter for boyling than the drill'd; which Quality draws moſt of theſe Cuſtomers to them, and when they are too thick, if they take them with Diſcretion, they may rather mend than ſpoil the ſown Crop; not that they will ſpare the drill'd* Turneps *for this laſt Reaſon (for they care not what Injury they do) but becauſe they* like *not the Taſte of them ſo well as that of the ſown.*

But notwithſtanding the Actions of theſe People are lawful in deſtroying my Crops, becauſe prohibited effectually *by no* Law; *yet I cannot help thinking it very hard, after paying four Shillings in the Pound to the Poor's tax, and extravagantly for the little Hand-Work beſtow'd on my* Turneps, *that the beſt Product of my Incloſures ſhould not be my own. But, to ſpeak properly, there can be no Incloſures, where every Foot of Ground that lies without Doors is now common to theſe People.*

The particular Scheme of raiſing conſtant annual Crops of Wheat *without Dung or Fallow, is as yet only upon Probation; but by the ſix Crops I have had in that Manner, I ſee nothing againſt their being continued: This, 'tis true, requires greater Care in the Management than any other Branch of the* Husbandry; *but he who can do this without Dung or Fallow, may eaſily do it with one or both of them: And there may be ſuch wet clayie Land, which the* Plow *cannot well pulverize without help of the Ferment of Dung; and in any Sort of Land, when 'tis ſuſpected that the Earth of the Partitions was not well ordered in the* Summer, *the beſt Remedy is to ſtrow a ſmall Quantity of* Malt-Duſt, *or other* fine *Manure upon the Rows about the Month of* February; *this will ſtrengthen the* Plants, *and enable them to ſend their Roots into the Intervals the earlier in the* Spring.

Againſt the Neceſſity of ſuch wide Intervals as I like beſt, my Neighbour tells me, he has had five ſucceſſive Crops of Wheat, and allows only four Foot Breadth to each Row and its Interval: His Rows have been ſometimes double and ſometimes treble: But his Ground is better than mine, and he beſtows more Hand-Work upon it.

Many, 'tis like, will think this Repetition of Wheat-Crops rather a Curioſity than profitable, and in ſome Circumſtances it may be ſo.

For planting a ſingle Crop there are ſeveral Methods: The narroweſt Interval wherein the Hoe-Plow can be profi-

profitably exercis'd among Corn, is of thirty Inches, and if this ſhould be uneven *by being the* parting *Space, it could not be Horſe-Hoed; therefore to keep it* even, *the Drill muſt have two Shares thirty Inches aſunder, the Horſe-Path being in the Middle betwixt them; by this Means the Partition, whoſe* Evenneſs *is not ſo neceſſary, will be the* parting *Space; but take care that the Point of one Share do not incline downwards more than the other; for if it ſhould, it will run very* deep *into the Ground, and the other will go very* ſhallow. *Alſo be ſure not to let the Hoe-Plow go forwards and backwards immediately in the ſame Interval; for if it does, the Furrows will all lie on the ſame Side, and then at the next Hoeing, the Plow muſt go twice the Length of each Interval to plow one ſingle Furrow; but this Inconvenience is eaſily prevented when foreſeen.*

I have had many of theſe ſingle Crops of Wheat in double Rows, and always obſerv'd it to be made very ſtrong by the Uſe of the Hoe only; but I chuſe to have the Intervals five or ſix Inches wider.

There may be another Way, to have one Crop of Wheat, not yet mention'd, and this is to go with the treble Drill twice inſtead of once upon each of the broad Ridges, which will make ſextuple *Rows with five Partitions of ſeven Inches each. I had an Example of this the laſt Year on one outſide Ridge. The firſt and ſixth of theſe Rows ſtanding next to the Hoed Earth were* ſtrong, *and ſo were the third and fourth that ſtood on the Top of the Ridge; but the ſecond and fifth ſtanding lower, fell vaſtly ſhort of the reſt; yet if theſe laſt had had more fine Mould under them, I do not doubt but they might have been equal or nearly equal to the other.*

The worſt Error I apprehend the Beginner will be liable to, is to expect the Benefit of Pulveration *where his Land is not pulveriz'd. I had this Year in the Middle of a Field of Wheat, about two or three Acres, the Earth of whoſe Partitions miſs'd one of the Hoeings in the pre-*

cedent Summer; the Colour of this Wheat was plainly diſtinguiſhed from that of the Wheat on both Sides of it at half a Mile's Diſtance in the Spring, and was not above half the Crop at Harveſt; but if the reſt of the Piece had not had a Hoeing more than this had, the Whole then being alike poor, it would not have ſo plainly appeared, that the Poverty was for want of one more Hoeing.

By what I can hitherto obſerve in this Husbandry, the beſt Management always ſucceeds beſt, contrary to the Proverb *that ſays, That once in ſeven Years, the* worſt *Husbands have the* beſt *Corn; which ſhews, that ſometimes even to this Day,* Ceres *prefers her* Virgilians *for their* Demerits.

Although Wheat, as an exportable Commodity, be the fitteſt for a general Improvement; yet in ſome particular Places, other Vegetables, ſuch as Rape, *or* Woad *may be more profitable than any Sort of Corn; and I have been told by one who has been long a Dealer in* Rape, *that he has made it larger and ſtronger in poor Land by Horſe-Hoeing, than he could ever make it in the richeſt Land by the common Method.*

What Pretenders or Impoſtors have taught or ſaid of this Husbandry is unknown to me; nor am I anſwerable for any Follies they may have committed, ſince I gave ſufficient Cautions againſt them in my Preface *to the* Specimen *publiſh'd for that Purpoſe almoſt two Years ago. To magnify it above what is juſt may be as injurious as ignorantly to undervalue it: If any have gone* raſhly *into the Practice of it, 'tis probable they may go as* raſhly *out of it, before they rightly know what it is.*

Some ſeem to have no other Notion of it, but as of a Trick to get Money, and write to me to ſend them Servants to inſtruct them in it, not conſidering how that Maſter is likely to be taught, *who muſt* learn *of his Servant, or that the being his* Scholar *might in one Senſe juſtify*

juſtify the Practice (which is now become cuſtomary) of the Plowman's correcting his Titular Maſter.

'Tis the moſt formidable Objection againſt our Agriculture, that the Defection of Servants and Labourers is ſuch, that few Gentlemen can keep their Lands in their own Hands, but rather than make nothing *of them, they* let *them for a* little *to Tenants, who can bear to be inſulted, aſſaulted, kick'd, cuff'd, and Bridewell'd with more Patience than Gentlemen are endow'd with.*

'Tis a publick Calamity, that the Lands of a Country muſt be all or moſtly in the Hands of Rack-Renters, whoſe Intereſt it is (or at leaſt they think ſo) that they never may be improv'd: We need not wonder at this when we ſee Copy-holders and Leaſe-holders for Lives oppoſe the Improvement of Incloſures for Fear their Fines *ſhould be* raiſed.

The very different Regard which every Man naturally hath to the Intereſt of his Heirs, from that of his Succeſſors, may be ſeen by the Poverty and unimprov'd Condition of St. Peter's *Patrimony compared with the hæreditary States of* Italy: *And can we ſuppoſe that an* Engliſh Renter *ſhould have more Honour in that Reſpect than his* Roman Holineſs, *who doth not fear being turn'd out by a Succeſſor in his Life-Time, as the Renter is ſure to be when his Leaſe is ended if he has improv'd his Farm and will not raiſe his Rent?*

The Diſreputation that Gentlemens Underſtandings lie under of wanting Capacity *to* manage *their Lands with Profit, as well as the moſt ignorant of the People can, would appear very unjuſt, could Gentlemen contrive* Automata *to do the Buſineſs appertaining to Tillage without Hands, at the Price that is reaſonable to be given to Servants and Labourers for the ſame: Not that there is any Want of Hands to receive our Money, to take away our Goods, and to beat us; but ſuch are wanting as will work faithfully at reaſonable Wages:*

By the general Complaint of their Behaviour, they more reſemble French *Dragoons in Time of Perſecution, than Servants. 'Tis not long ſince the publick News gave an Account of a noble Lord's being inſulted by* Footmen *in the* Royal Palace; *if thus be their Manners when poliſh'd at* Court, *what* Idea *can be fram'd of their* Inſolence *whilſt they follow the Plow in the* Country?

They who impute this Misfortune of the Land, to the Loſs *of the Common Law, which* favour'd Agriculture, *and was to our Anceſtors a* better Inheritance than that which came to them from their Parents; *pretend to prove, that the* Statute *of* Labourers *hath turn'd more Gentlemen out of their Eſtates than the* Norman Conqueſt *did; but their Arguments being too numerous to be here recited, I ſhall only give them this general Anſwer,* viz. *That the Lands of* France *are occupy'd with Pleaſure and Profit by the Owners, who live well upon them, and leave them planted and improved to their Heirs, after having paid almoſt as much in Taxes to their King, as our Tenants* pay *in Rent to their Landlords for better Land: And yet there is none of our* Common Law *in* France; *every Thing* there *is decided by* Trials *at* Diſcretion; *but then, indeed, as the Magiſtrates are* arbitrary *over the People, ſo the King is arbitrary over the Magiſtrates, and in Favour of Tillage he will not ſuffer, that the Poſſeſſors of Land ſhall be trampled on by Servants and Labourers, or other* Infimates *of the Country: Servants muſt* there *obey their Maſters, as far as is neceſſary for carrying on their Buſineſs; and the Labourer muſt be* worthy of his Hire; *for if when he is able he will not* work, *neither ſhall he* eat: *And they are ſo unaccuſtomed to Idleneſs, that none are* ſtarved, *that I can hear of.*

This may perhaps ſerve for an Anſwer to thoſe who aſſert, that there can be no Juſtice without Juries; *but whatever becomes of our Lands, I pray God to defend us againſt a* French *Government in* England.

I can hardly believe, that the enormous Behaviour of Servants, &c. *is ſo* general *as 'tis commonly reported to be: Sure the Freeholders of Counties would petition their reſpective* Repreſentatives in Parliament, *in hopes, that ſo publick and heavy a* Grievance *might be redreſs'd; for the ſame Power which took away Part of the Common Law can reſtore it in its priſtine Purity, and enable the Owners of Lands to occupy and improve them as freely, at leaſt, as their Anceſtors might before* 5. Eliz.

The Hoeing Practice would profitably employ many more Hands, than the common Husbandry, and procure more Bread for them: But if through the aforeſaid unfortunate Circumſtances it cannot be frequent in South Britain, *which ſeems to be the moſt proper Climate in the World for it; yet if it ſhall be uſeful to any other of his Majeſty's Dominions, I ſhall think my Labour amply rewarded by that Succeſs. And even* here *thoſe very Inconveniences that attend Arable Land make the Improvement by* St. Foin *the greater; and in this many others as well as myſelf have found my Drill to be very advantageous; not that the Drill is neceſſary for planting it in all Lands; for in moſt Soils that are rich and proper,* St. Foin *will proſper and laſt, in what Manner ſoever 'tis planted; but in a Chalk with a poor thin Staple, I never knew it ſucceed, unleſs when it was properly drill'd, or elſe yearly manur'd by Peat-Aſh, Soot, or Coal-Aſh, at a great Expence.*

The Drill may alſo be ſerviceable to the old Husbandry in ſome Reſpects, as when Land having been plowed dry, and lain till the Rain comes, its Surface is grown ſo hard, that the Seed-Wheat cannot be cover'd by Harrows or Drags, then the Drill will make Channels, ſow in the Seed, and cover it effectually.

Another general and no inconſiderable Advantage of its Uſe is, that it can ſave more than half the Seed that is ſown, and plant the Land better (they may al-

ſo hand-hoe between the neareſt Rows if they pleaſe, or pull out the Weeds without treading on the Corn) but it ſaves more of ſome Sorts of Seed than of others.

The firſt Occaſion of making my Drill for ſmall *Seeds was this: It was very difficult to find a Man that could ſow Clover tolerably; they had a Habit (from which they could not be driven) to throw it once with the Hand to two large Strides, and go twice on each Caſt; thus with nine or ten Pound of Seed to an Acre, two Thirds of the Ground was unplanted, and on the reſt 'twas ſo thick that it did not proſper. To remedy this, I made a Hopper to be drawn by a Boy that planted an Acre ſufficiently with ſix Pound of Seed; but when I added to this Hopper an exceeding light Plow, that made ſix Channels eight Inches aſunder, into which two Pound to an Acre being drill'd, the Ground was as well planted. This Drill was eaſily drawn by a Man, and ſometimes by a Boy.*

But the Sort of Seed of which the moſt is ſaved by the Drill is St. Foin, *for nineteen Parts of twenty may be* well *ſaved by it.*

I fear my Deſcriptions in the five laſt Chapters, for want of technical Words, may not be ſo perſpicuous as I could wiſh; and that there may be ſome little Errors in the Plates by Reaſon of the Diſtance I live at from Engravers; but I hope there is none in any material Part, and that by the Cuts and their Explanations all theſe Inſtruments may be made to perform perfectly: And I ſuppoſe 'tis impoſſible to make a bad Drill to agree with all the Rules there laid down.

Every Figure *of the Drill is in its full Dimenſions where none are given. If the Angle of Inclination of the Sides of the Mortiſe ſhould be but of ſix Degrees inſtead of eight, in the wide Boxes there deſcribed it might do well enough: but in narrow Mortiſes, for drilling* rough *Seeds, eight Degrees of Inclination are neceſſary; as when formerly I drilled* St. Foin *with Mortiſes* *three Quarters of an Inch wide, the Wheels being low. Indeed If I were now to make a Drill for* St. Foin *only, even on high Wheels, the Mortiſes ſhould not exceed one Inch in width: And then eight Degrees of Inclination would be ſafer than ſix, and eight are not injurious to the wideſt Mortiſe, but only in the wide there is not that Exactneſs required as is in the narrow.*

I am ſorry it happen'd, that it was not in my Power to deſcribe in Cuts (not having it by me) a particular Drill for planting Turneps between Rows of Corn, both in wide and in narrow Intervals; the Advantage is ſuch, that being but ſmall *at Harveſt, they do no perceivable Damage to the Corn, and yet afterwards grow* large *by Hoeing, and being fed off by Sheep in the Winter, afford conſiderable Profit, and alſo enrich the Land for a following Spring-Crop of Corn.*

This Drill muſt have only one Share, and that muſt go on the pulveriz'd Earth very near to the Row, and one Wheel only, to go in the Middle of the Interval; the Hopper faſtened immoveably to the Plow, in ſuch a Manner, that nothing may take hold of the Corn. It may be drawn by a Man.

One Cauſe that made the three Parts of the Book (that is to ſay, the Theory, or ſpeculative Part, the practick Part, and the Deſcriptions of the Tools) the more defective was, that all three were too many for me to make perfect at once*; and two would have been uſeleſs without the third; therefore it was better to give but a Sketch of all, than to have made any two of them never ſo full and perfect, leaving out the other. But if this my firſt Eſſay ſhould meet with Encouragement, 'tis poſſible (tho' barely poſſible) that I may write a* Supplement *containing Amendments and Additions to every Part, together with Anſwers to Objections, which 'tis impoſſible for me to anſwer before they are* made, *or before I am* appriſed *of them.*

CHAP. I. *Of ROOTS.*

SINCE the moſt immediate Uſe of *Agriculture*, in feeding Plants, relates to their *Roots*, they ought to be treated of in the firſt Place.

Roots are very different in different Plants, but 'tis not neceſſary here to take notice of all the nice Diſtinctions of them; therefore I ſhall only divide them in general into Two Sorts, *viz. Horizontal-Roots*, and *Tap-Roots*, which may include them all.

All have Branchings and Fibres going all manner of ways, ready to fill the Earth that is open.

But ſuch *Roots* as I call Horizontal (except of Trees) have ſeldom any of their Branchings Deeper than the Surface or Staple of the Earth, that is commonly mov'd by the Plow or Spade.

The Tap-Root commonly runs down Single and Perpendicular, reaching ſometimes many Fathoms below.

This (tho' it goes never ſo deep) has Horizontal ones paſſing out all round the Sides; and extends to ſeveral Yards diſtance from it, after they are by their minuteneſs, and earthly Tincture, become Inviſible to the naked Eye.

A Method how to find the Diſtance to which *Roots* extend Horizontally.

A Piece or Plot dug and made fine in whole hard Ground, the end *A* 2 Foot, the end *B* 12 Foot, the length of the Piece 20 Yards; the Figures in the middle of it are 20 *Turneps*, ſown early and well Ho'd.

The manner of its Hoeing muſt be at firſt near the Plants, with a Spade, and each time afterwards, a Foot farther diſtance, 'till all the Earth be once well dug; and if Weeds appear where it has been ſo dug, Hoe them out ſhallow with the Hand-Hoe. But dig all the Piece next the out Lines deep every time, that it may be the finer for the *Roots* to enter, when they are permitted to come thither.

If theſe *Turneps* are all gradually bigger, as they ſtand nearer to the end *B*, 'tis a Proof they all extend to the outſide of the Piece, and the *Turnep* 20, will appear to draw Nouriſhment from Six Foot diſtance from its Center.

But if the *Turneps* 16, 17, 18, 19, 20, acquire no greater Bulk than the *Turnep* 15, it will be clear, that their *Roots* extend no farther than thoſe of the *Turnep* 15 does; which is but about 4 Foot.

By this Method the Diſtance of the Extent of *Roots* of any Plant, may be diſcover'd.

There is alſo another way to find the Length of *Roots*, by making a long narrow Trench, at the diſtance you expect they will extend to, and fill it with Salt, if the Plant be killed by the Salt, 'tis certain that ſome of the *Roots* enter into it.

What put me upon this Method was an Obſervation of Two Lands (or Ridges) drill'd with *Turneps* in Rows, a Foot aſunder, and very even in them; the Ground, at both ends and one ſide, was hard and unplow'd, the *Turneps* not being Hoed, were very Poor, Small, and Yellow, except the Three outſide Rows, *B*, *C*, *D*, which ſtood next to the Land (or Ridge) *E*, which Land being Plow'd and Harrow'd, at the time the Land *A* ought to have been Hoed, gave a dark flouriſhing Colour to theſe three Rows; and the *Turneps* in the Row *D*, which ſtood fartheſt off from the new Plow'd Land *E*, received ſo much Benefit from it, as to grow Twice as big as any of the more diſtant Rows. The Row *C*, being a Foot nearer to the new Plow'd Land, became twice as large as thoſe in *D*; but the Row *B*, which was next to the Land *E*, grew much larger yet.

F is a Piece of hard whole Ground, of about two Perch in length, and about 2 or 3 Foot broad, lying betwixt thoſe Two Lands, which had not been Plow'd that Year; 'twas remarkable, that during the length of this Interjacent hard Ground, the Rows *B*, *C*, *D*, were as Small and Yellow as any in the Land.

The *Turneps* in the Row *D*, about three Foot diſtant from the Land *E*, receiving a double Increaſe, proves they had as much Nouriſhment from the Land *E*, as from the Land *A*, wherein they ſtood; which Nouriſhment was brought by leſs than half the number of *Roots* of each of theſe *Turneps*.

In their own Land they muſt have extended a Yard all round, elſe they could not have reach'd the Land *E*, wherein 'tis probable theſe few Roots went more than another Yard, to give each *Turnep* as much Increaſe as all the Roots had done in their own Land.

Except that it will hereafter appear, that the new Nouriſhment taken at the Extremities of the Roots in the Land *E*, might enable the Plants to ſend out more new Roots in their own Land, and receive ſomething more from thence.

The Row *C* being Twice as big as the Row *D*, muſt be ſuppos'd to extend Twice as far; and the Row *B*, four times as far, in proportion as it was of a Bulk Quadruple to the Row *D*.

And 'tis obſervable, that betwixt theſe two Lands, there was a Trench, or Furrow, of about the Depth of Nine or Ten Inches, where theſe Roots muſt deſcend firſt, and then aſcend into the Land *E*: but it muſt be noted, that ſome ſmall Quantity of Earth was, by the Harrowing, fall'n into this Furrow, elſe the Roots could not have paſs'd thro' it.

Roots will follow the open Mould, (*) by deſcending Perpendicularly, and mounting again in the ſame manner: As I have obſerv'd the Roots of a

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(*) A Chalk-Pit, contiguous to a Barn, the Area of which being about 40 Perch of Ground, was made clean, and ſwept; ſo that there was not the Appearance of any Part of a Vegetable, more than in the Barn's Floor: Straw was thrown from thence into the Pit, for Cattle to ly on: The Dung made thereby was carried away about Three Years after the Pit had been cleanſed; when, at the Bottom of it, and upon the Top of the Chalk, the Pit was cover'd all over with Roots, which came from a Witch-Elm, not more than Five or Six Yards in Length, from Top to Bottom, and which was about Five Yards above, and Eleven Yards from the Area of the Pit; ſo that in Three Years the Roots of this Tree extended themſelves Eight times the Length of the Tree, beyond the Extremities of the Old Roots, at Eleven Yards diſtance from the Body: The Annual-increaſed Length of the Roots was near Three times as much as the Heighth of the Tree.

Wheat Drill'd in double Rows in *November*, in a Field well Till'd before Planting, look'd Yellow, when about Eighteen Inches high; at Two Foot diſtance from the Plants, the Earth was Hoe-Plow'd, which gave ſuch Nouriſhment to 'em, that they recover'd their health, and changed their ſickly Yellow, to a lively Green Colour.

A *Turnep* has a Tap-Root, from whence all the Horizontal-Roots are derived.

Hedge to do, that have paſs'd a ſteep Ditch two Foot deep, and reach'd the Mould on the other ſide, and there fill it; and digging Five Foot diſtant from the Ditch, found the Roots large, tho' this Mould was very ſhallow, and no Roots below the good Mould.

So in an Orchard, where the Trees are planted too Deep, below the Staple or good Mould, the Roots, at a little diſtance from the Stem, are all as near the upper Superficies of the Ground, as of thoſe Trees, which are Planted higher than the Level of the Earth's Surface.

But the Damage of Planting a Tree too low in moiſt Ground is, that in paſſing through this low part, ſtanding in Water, the Sap is Chill'd and its Circulation thereby retarded.

One Cauſe of People's not ſuſpecting Roots to extend to the Twentieth part of the Diſtance, which in reality they do, was from obſerving theſe Horizontal-Roots, near the Plant, to be pretty Taper; and if they did Diminiſh on, in Proportion to what they do there, they muſt ſoon come to an end. But the Truth is, that after a few Inches, they are not diſcernibly Taper, but paſs on to their ends very nearly of the ſame bigneſs; this may be ſeen in *Roots* growing in Water, and in ſome other, tho' with much Care and Difficulty.

In pulling up the afore-mention'd *Turneps*, their Roots ſeem'd to end at few Inches diſtance from the Plants, they being farther off, too fine to be perceiv'd by ordinary Obſervation.

I found an extream ſmall Fibre on the ſide of a *Carrot*, much leſs than a Hair, but through a Microſcope it appear'd a large Root, not Taper, but broken off ſhort at the end, which it's probable might have (before broken off) extended near as far as the *Turnep* Roots did. It had many Fibres going out of it, and I have ſeen that a *Carrot* will draw Nouriſhment from a great Diſtance, tho' the Roots are almoſt Inviſible, where they come out of the *Carrot* itſelf.

By the Piece *F* may be ſeen, that thoſe Roots cannot penetrate, unleſs the Land be open'd by Tillage, *&c.*

And 'tis very likely, and may be prov'd by another Method, That as Roots are but as Guts inverted, they do bear perhaps that Proportion to the Stem or Stalks of Plants, as Guts do to the Bodies of Animals, (*) *viz.* Several times longer than the Stalks.

As Animals of different Species have their Guts bearing different Proportions to the length of their Bodies; ſo 'tis probable, different Species of Plants may have their Roots as different. But if thoſe which have ſhorter Roots have more in Number, and having ſet down the means how to know the Length of them in the Earth, I leave the different lengths of different Species to be examin'd by thoſe who will take the Pains of more trials. This is enough for me, that there is no Plant commonly Propagated, but what will ſend out its Roots far enough, to have the Benefit of all the Hoed Spaces or Intervals, I in the following Chapters allot them, even tho' they ſhould not have Roots ſo long as their Stalks or Stems.

(Roots of amphibious Plants grow longer, when in Earth, than when in Water.)

And this great length of Roots will appear very reaſonable, if we compare the largeneſs of the Leaves, (which are the Parts ordain'd for Excretion)

(*) An Animal has but one Gut, tho' its Parts be diſtinguiſh'd by ſeveral Names; and the greater Number of Roots a Plant has, the leſs Length of them will ſuffice.

with the ſmallneſs of the Capillary Roots, which muſt make up in Length or Number what they want in Bigneſs, being deſtin'd to range far in the Earth, to find out a ſupply of Matter to maintain the whole Plant; whereas the chief office of the Stalks and Leaves, is only to receive the ſame, and to diſcharge into the Atmoſphere ſuch part thereof as is found unfit for Nutrition; a much eaſier Task than the other, and conſequently fewer Paſſages ſuffice, theſe ending in an obtuſe form; for otherwiſe the Air would not be able to ſuſtain the Stalks and Leaves in their upright Poſture; but the Roots, tho' very weak and ſlender, are eaſily ſupported by the Earth, notwithſtanding their Length, Smallneſs and Flexibility.

Plants have no Stomach, nor *Æſophagus*, which are neceſſary to convey the maſs of Food to an Animal: which maſs being exhauſted by the Lacteals is Eliminated by way of Excrements but the Earth itſelf being that maſs to the Guts(or Roots) of Plants, they have only fine Recrements, which are thrown off by the Leaves.

In this, Animal and Vegetable Bodies agree, that Guts and Roots are both Injured by the open Air; and Nature has taken an equal care, that both may be ſupply'd with Nouriſhment (without being expos'd to it.) Guts are ſupply'd from their Inſides, and Roots from their Outſides.

All the Nutriment (or *Pabulum*) which Guts receive for the uſe of an Animal, is brought to them; but Roots muſt ſearch out and fetch themſelves all the *Pabulum* of a Plant; therefore a greater quantity of Roots, in Length or Number, is neceſſary to a Plant, than of Guts to an Animal.

All *Roots* are as the Inteſtines of Animals, and have their Mouths or Lacteal Veſſels opening on their outer ſpongy Superficies, as the Guts of Ani-

mals

mals have theirs opening in their inner ſpongy Superficies.

The Animal Lacteals take in their Food by the preſſure that is made from the Periſtaltick Motion, and that Motion caus'd by the Action of Reſpiration, both which Motions preſs the Mouths of the Lacteals againſt the Maſs or Soil which is within the Guts, and bring them into cloſer contact with it.

Both theſe Motions are ſupply'd in Roots by the preſſure occaſion'd by the Increaſe of their Diameters in the Earth, which preſſes their Lacteal Mouths againſt the Soil without. But in ſuch Roots as live in Water, a Preſſure is conſtantly made againſt the Roots by the weight and fluidity of the Water; This preſſes ſuch fine Particles of Earth it contains, and which come into contact with their Mouths, the cloſer to them.

And when *Roots* are in a Till'd Soil, a great preſſure is made againſt them by the Earth, which conſtantly ſubſides and preſſes their Food cloſer and cloſer, even into their Mouths; until it ſelf bebomes ſo hard and cloſe, that the weak ſorts of Roots can penetrate no farther into it, unleſs re-open'd by new Tillage, which is call'd Hoeing.

The Colour of the Roots being different from that of Leaves, and ſome other external parts of a Plant, is no more an Argument againſt the Circulation of the Sap, than the Colour of the Guts, being different from that of the Lungs, and other Parts of an Animal Body, is an Argument againſt the Circulation of the Blood.

As far as I can yet diſcover, all Roots, properly ſo call'd, are White; and a Red Carrot, when it ſtands for Seed, ſends out in the Spring from all Parts of it, Fibrous Roots, as White as thoſe of any other Plant. The White Colour proceeds from the Chyliferous Veſſels.

When a good Number of Single-Mint Stalks had ſtood in Water, until they were well ſtock'd with Roots from their Two Lower Joints, and ſome of them from Three Joints, I ſet one into a Mint-Glaſs, mark'd *A*, full of Salt-water, this Mint *A* became perfectly dead within Three days.

Another *Mint*, mark'd *B*, I put into a Glaſs of fair Water, but I immers'd one ſtring of its Roots (being brought over the Top of that Glaſs) into another Glaſs of Salt-water, contiguous to the Top of the other Glaſs; This *Mint* dy'd alſo very ſoon.

Of another, mark'd *C*, (ſtanding in a Glaſs of Water and Earth till it grew Vigorouſly) I ty'd one ſingle Root into a Bag, which held a Spoonful of dry Salt, adjoining to the Top of the Glaſs, which kill'd this ſtrong Mint alſo. I found that this Salt was ſoon diſſolv'd, tho' on the outſide of the Glaſs; and tho' no Water reach'd ſo high, as to be within Two Inches of the Joint which produc'd this Root: The Leaves of all theſe were ſalt as Brine to the Taſte.

Of another, mark'd *D*, I put an upper Root into a ſmall Glaſs of Ink, inſtead of a Bag of Salt, in the manner above mention'd: this Plant was alſo kill'd by ſome of the Ink Ingredients. The Blackneſs was not communicated to the Stalk, or Leaves, which inclin'd rather to a Yellowiſh Colour as they died, which ſeem'd owing to the *Copperas*.

I made a very ſtrong Liquor with Water, and bruiſed Seeds of *Wild-Garlick*, and filling a Glaſs therewith, plac'd the Top of it cloſe to the Top of another Glaſs, having in it a Mint, mark'd *E*, Two or Three of whoſe upper Roots, put into this ſtinking Liquor, full of the bruiſed Seeds, and there remaining, it kill'd the Mint in ſome time, but it was much longer in dying than the others were with Salt and Ink. It might be, becauſe theſe Roots in the *Garlick* were very ſmall, and did not bear ſo great a Proportion to their whole Syſtem of Roots, as the Roots, by which the other Mints were poiſon'd, did to theirs.

When the Edges of the Leaves began to change Colour, I chew'd many of them in my Mouth, and found at firſt the ſtrong Aromatick flavour of Mint, but that was ſoon over; and then, the nauſeous taſte of *Garlick* was very perceptible to my Palate.

I obſerv'd, that when *Mint F* had ſtood in a Glaſs of Water, until it ſeem'd to have finiſh'd its growth, the Roots being about a Foot Long, and of an earthy Colour, after putting in ſome fine Earth, which ſunk down to the bottom, there came from the upper Joint a new Sett of White Roots, taking their courſe on the outſide of the heap of Old Roots downwards, until they reach'd the Earth at the bottom, and then after ſome time came to be of the ſame earthly Colour with the Old ones.

The *Mint G* being well rooted from Two Joints, about Four Inches aſunder, I plac'd the Roots of the lower Joint in a deep Mint-Glaſs, having Water at the bottom, and the Roots of the upper Joint into a ſquare Box, contriv'd for the purpoſe, ſtanding over the Glaſs, and having a bottom, that open'd in the middle with a Hole, that ſhut together cloſe to the Stalk, juſt below the upper Joint; then laying all theſe upper Roots to one Corner of the Box, I fill'd it with Sand, dry'd in a Fire-ſhovel, and found, that in one Night's time, the Roots of the lower Joint, which reach'd the Water at the bottom of the Glaſs, had drawn it up, and imparted ſo much thereof to thoſe Roots in the Box above, that the Sand, at that Corner where they lay, was very wet, and the other Three Corners dry. This Experiment I repeated very often, and it always ſucceeded as that did.

And for the ſame purpoſe I prepar'd a ſmall Trough, about Two Foot Long, and plac'd a Mint-Glaſs under each end of the Trough; over each Glaſs I plac'd a Mint, with half its Roots in the Glaſs, the other half in the Trough: The Mints ſtood juſt upon the ends of the Trough. Then I cover'd theſe Roots with pulveriz'd Earth, and kept the Glaſſes ſupply'd with Water; and as oft as the white fibrous Roots ſhot thro' the Earth, I threw on more Earth, 'till the Trough would hold no more, and ſtill the white Fibres came thro', and appear'd above it, but all ſeem'd (as I ſaw by help of a courſe Microſcope) to turn, and when they came above Ground, their Ends enter'd into it again. Theſe Two *Mints* grew thrice as Large as any other *Mint* I had, which were many, that ſtood in Water, and much larger than thoſe which ſtood in Water with Earth in it: They being all of an equal bigneſs when ſet in, and ſet at the ſame time. Though theſe Two ſtanding in my Chamber, never had any Water in their Earth, but what thoſe Roots, which reach'd the Water in the Glaſſes ſent up to the Roots, which grew in the Trough. The vaſt quantity of Water theſe Roots ſent up, being ſufficient to keep all the Earth in the Troughs moiſt, tho' of a Thouſand times greater quantity than the Roots which water'd it, makes it probable, that the Water paſs'd out of the Roots into the Earth, without mixing at all with the Sap, or being alter'd to any degree. The Earth kept always moiſt, and in the Hot Weather there would not remain a Drop of Water in the Glaſſes, when they had not been freſh ſupply'd in Two Days, and One Night; and yet theſe Roots in the Glaſſes were not dry'd, tho' they ſtood ſometimes a whole Day and Night thus in the empty Glaſſes. Theſe Two Mints have thus liv'd all one Summer, and are mark'd *H H.*

Remarks on the *Mints*, &c. Tho' the Veſſels of Marine Plants be ſome ways fortify'd againſt the Acrimony of Salt, as Sea-fiſh are: Yet the Mints *A*, *B*, *C*, all ſhew, that Salt is Poiſon to other Plants.

The Reaſon why the Salts in Dung, Brine, or Urine, do not kill Plants in the Field or Garden, is, that their Force is ſpent in acting upon, and dividing the Parts of Earth; neither do theſe Salts, or at leaſt any conſiderable Quantity of them, reach the Roots.

I try'd Salt to many Potatoes in the Ground, being undermin'd, and a few of their Roots put into a Diſh of Salt-water, they all Died ſooner or later, according to their Bigneſs, and to the Proportions the Quantity of Salt apply'd did bear to them.

By the Mints *B*, *C*, *D*, *E*, it appears that Roots make no diſtinctions in the Liquor they imbibe, whether it be for their Nouriſhment or Deſtruction. And that they do not Inſume what is diſagreeable, or Poiſon to them, for lack of other Suſtenance; ſince they were very vigorous, and well fed in the Glaſſes, at the time when the moſt inconſiderable Part of their Number had the Salt, Garlick, and Ink offer'd to them.

The *Mint F* ſhews, that when new Earth is apply'd to the old Roots, a Plant ſends out new Roots on purpoſe to feed on it: And that the more Earth is given it, the more Roots will be form'd, by the new Vigour the Plant takes from the addition of Earth. This correſponds with the Action of Hoeing; for every time the Earth is mov'd about Roots, they have a Change of Earth, which is New to them.

The *Mint G* proves, that there is ſuch a Communication betwixt all the Roots, that when any of them have Water, they do impart a ſhare thereof to all the reſt: And that the Root of the lower Joint of this Mint, had Paſſages (or Veſſels) leading from them, through the Stalk, to the Roots of the upper Joint; tho' the clear Stalk (through which it muſt have paſs'd) that was betwixt theſe Two Joints, was ſeveral Inches in Length.

This accounts for the great Produce of Long-taprooted Plants, ſuch as *Luſern* and *St. Foin*, in very dry Weather: For the Earth at a great Depth is always moiſt. It accounts alſo for the good Crops we have in dry Summers, upon Land that has a Clay bottom; for there the Water is retain'd a long time, and the lower Roots of Plants which reach it, do like thoſe of this Mint, ſend up a ſhare to all the higher Roots.

If thoſe Roots of a Plant, which lie at the Surface of the Ground, did not receive moiſture from other Roots which lie deeper, they could be of no uſe in dry Weather. But 'tis certain, that if this dry Surface be mov'd or dung'd, the Plant will be found to grow the faſter, tho' no Rain falls; which ſeems to prove, both that the deep Roots communicate to the ſhallow, a ſhare of their Water, and receive in return from them a ſhare of Food, in common with all the reſt of the Plant, as in Mints *F*, *G*, *H H*, they did.

The Two *Mints*, mark'd *HH*, ſhew, that when the upper Roots have moiſture (as they had in the Earth in the Trough, carried thither firſt by the lower Roots) they impart ſome of it to the lower, elſe theſe could not have continu'd Plump and Freſh, as they did for 24 Hours in the empty Glaſs, and I have ſince obſerved them to do ſo, in the cooler Seaſon of the Year, for ſeveral Weeks together, without any other Water, than what the upper Roots convey'd to them, from the moiſt Earth above in the Trough. I know not what time theſe Roots might continue to be ſupply'd thus in the hot Weather, becauſe I did not try any longer, for fear of killing them.

But it muſt be noted, that the Depth of the Glaſs protected the Roots therein from the Injury of the Motion of the free Air, which would have dry'd them, if they had been out of the Glaſs.

In this Trough is ſhewn moſt of the Hoeing Effects, *viz.* That Roots, by being broken off near the Ends, encreaſe their Number, and ſend out ſeveral where one is broken off.

That the Roots encreaſe their Fibres every time the Earth is ſtirr'd obout them.

That the ſtirring the Earth makes the Plants grow the faſter.

The *Mint* diſcharging ſuch a vaſt quantity of Water into the Earth in the Trough, ſhews that there are Paſſages by which the Roots do as it were ſpew out, what is ſuperfluous, and would ſurfeit the Plant, if it entered into the Sap in too great abundance, more and faſter than it could be purify'd by the Leaves.

Whether this Water, which is ſo ſoon return'd out of the Roots, be at all alter'd, during its ſhort ſtay there, I can't ſay, till I ſee the Conſequence of ſome Experiments, which will, I believe, inform me, *viz.*

Half the fibrous Root of *Garlick* ſet in Water, the other Half in a Trough of Flower above it, as thoſe of the *Mint* were; if the Water the under Garlick Roots ſend to the upper, be ſpew'd out into the Flower of a Garlick taſte, then we know 'tis alter'd, otherwiſe conclude 'tis not alter'd. A *Mint* is not of Flavour ſtrong enough to prove this.

Chap. II. *Of LEAVES.*

LEAVES are the Parts, or Bowels of a Plant, which perform the ſame Office to Sap, as the Lungs of an Animal do to Blood; that is, they purify or cleanſe it of the Recrements, or fuliginous Steams, receiv'd in the Circulation, being the unfit Parts of the Food; and perhaps ſome decay'd Particles, which fly off the Veſſels, through which Blood and Sap do paſs reſpectively.

Beſides which Uſe, the Nitro-aerious Particles may there enter, to keep up the vital Ferment or Flame.

Mr. *Papin* ſhews, that Air will paſs in at the Leaves, and out thro' the Plant at the Roots, but Water will not paſs in at the Leaves; and that if the Leaves have no Air, a Plant will die, but if the Leaves (being left on the outſide of the Receiver, parted by a Hole, cemented with Wax) have Air, tho' the Root remain in Water *in vacuo*, the Plant will live and grow.

Dr. *Grew*, in his Anatomy of Plants, mentions Veſſels, which he calls, Net-work, Cobweb, Skeins of Silk, *&c.* But above all, the multitude of Air-Bladders in them, which I take to be of the ſame uſe in Leaves, as the Veſiculæ are in Lungs. Leaves being as Lungs inverted, and of a broad and thin Form; their Veſiculæ are in Contact with the free open Air, and therefore have no need of Trachea, or Bronchia, nor of Reſpiration.

Lungs being ſituate within the Animal's Body, their Veſiculæ could have no Communication with the Atmoſphere, without the Trachea and Bronchia; and even there, the Aerial Influence would be intercepted by the fuliginous and recrementitious Steams, were they not thence expell'd by the Syſtole in Expiration; the want of which, is the Cauſe of an Aſthma, a Diſeaſe, Leaves are not affected with, becauſe their Veſiculæ are always contiguous to the nitrous Air, which continually preſſes againſt them.

Sanctorius, who by his Statick-Chair, found Five Eights of the Nouriſhment, or a Weight equal to it, taken by a Man, paſs off by inſenſible Perſpiration; could he have invented any Method to calculate the Quantity of that Part of thoſe Perſpirations, which paſs off through the Trachea from the Lungs, I believe he would have found the moſt of it to paſs that way (1).

When the Blood enters the Lungs, from the Right Ventricle of the Heart, 'tis ſo full of this fuliginous Matter, that its Colour is blacken'd with it. This is all diſcharg'd in paſſing thro' the Lungs; for when the Blood arrives at the Heart's left Ventricle being purify'd of its Recrements, 'tis become of a pure florid Red Colour; and in cold Weather theſe Steams may be ſeen to iſſue out from the Trachea in great Quantities, which are conſtantly ſupply'd by the Nouriſhment taken in at the Lacteals of the Guts. *Sanctorius*'s other Three Parts were but as the Soil, from whence the Five Parts are extracted.

Since Leaves do ſo much reſemble Lungs, in the Anatomy of their Organs, 'tis very reaſonable to believe, they imitate them in their Office; tho' the fineneſs of the Vegetable Veſſels, and ſlow Motion of the Sap, will not admit a Demonſtration of the Sap's Circulation by Ligatures; but we have other Reaſons which do ſufficiently prove it.

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(1) See Mr. *Papin*'s Experiments of the Pneumatick Engine; it appears, that Water will paſs out of the Leaves, but not from without into them; and that nothing can be found to paſs in or out by the Bark, unleſs the Bark be cut.

The Young *Potatoe* is nouriſh'd from the Plant (1), at the end of a White String, by Veſſels paſſing from the Bottom of the Plant; at the ſame time, when Salt being bound to this String, paſſes by other Veſſels of the ſame String, contrary to the other, into the Body of the Plant, and may be taſted in the Leaves.

A Quantity of Matter, near equal to that received by the Roots, is conſtantly carried off, as appears by Dr. *Woodward*'s Experiments; and I believe Nobody ever doubted, but that it had its chief Exit from the Leaves.

'Tis not likely, that all thoſe curious Veſſels, which appear in the Texture of a Leaf, ſhould be deſign'd for the Recrements and Sap to paſs once through them, and thence to fly away together; they might as well paſs off, without the uſe of the Leaves, at the Place where they are inſerted into the Plant, if the Leaves were off (2).

And

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(1) It muſt have its Nouriſhment from the Mother-Plant, becauſe the young *Potatoe* and ſtring, being laid on Tiles, could have no Nouriſhment from the Earth, and yet it will grow large, and have no Taſte of Salt in it, that being ſtopp'd in the Leaves, and kills the Mother *Potatoe*. If the Salt did enter the inmoſt Veſſels, that carry the Nouriſhment to the young One, that would taſte of the Salt, which is apply'd nearer to it, than to the Mother.

(2) Mr. *Hale*, in his Vegetable Staticks, found that a Plant in Summer imbibed and perſpired leſs Water, when its Leaves were pulled off, than when they were on; but this might be partly from the Contraction of the Veſſels by the Air, at the Wound where the Leaves were broken off. He alſo proves, that this Quantity of Liquor, that paſſes through a leafleſs Plant in Summer (though it be leſs than what paſſes through a Plant that has its Leaves on, is vaſtly greater than what paſſes through the ſame Plant in Winter; and yet the Plant with the great Quantity of Liquor (or Nouriſhment) in Summer will die; and yet will live with the leaſt in Winter. Hence it appears, that the taking in and paſſing of never ſo great a quantity of *Pabulum*, with its Vehicle through a Plant, will

not

And to think, that the Nouriſhment and Sap of a Plant paſs off together, is no leſs abſurd, than to think that the Blood and Chyle paſs off together in Perſpiration.

Or to what Purpoſe ſhould the Sap be Depurated in the Leaves, if it were not to be return'd back by other Veſſels; like *Arteriæ venoſæ*, into the Stem or Stalk of a Plant?

If no Circulation, the Sap and all other Juices muſt paſs off together, and then there would be no manner of uſe of the Veſſels of the Leaves as Strainers.

It would be very ſtrange, if what is pure Earth and Water, when it enters the Root, ſhould be transform'd into ſuch different Juices, by paſſing once through a Plant, as from an Alembick, and in ſo ſhort a time.

In

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not keep it alive, unleſs it has Leaves in Proportion to that Quantity, as all Plants have that live in Winter. It cannot then be deny'd, that Leaves are abſolutely neceſſary to the Life of a Plant, and if they are, it muſt be either on account of their conveying ſomething from it; or ſending ſomething to it: 'tis plain, it cannot be only by the former, becauſe that can be done without Leaves: they muſt therefore be neceſſary by the latter.

And as the Lungs would be of no benefit to an Animal, if the Blood, after it was ſecern'd and purify'd in them, were not returned to the Body, as well as received from it; ſo the Secretion made by Leaves would be of no benefit to the Plant, if none of the Sap there ſecern'd were returned back to it: Neither could the Air, taken in by the Leaves, be of any uſe to the reſt of the Plant, unleſs it did paſs from the Leaves along with the purify'd Sap into the Plant, by ſome Veſſel like the *Aorta.* And, I think, that whoever proves, that the Air paſſes from the Leaves into the Plant, ſufficiently proves the Circulation of the Sap, becauſe if the Sap did move always from the Plant to the Leaves, the Air could not paſs againſt the Stream of it.

It ſeems that the chief Arguments, that gave Mr. *Hale* a Suſpicion againſt the Circulation, are taken from the quick Paſſage of Liquor from the Root through the Plant, and his ſuppoſing

In ſuch caſe, either it muſt become perfect Sap in the Root, or elſe, when it firſt paſs'd thence, it would not be much different from Earth and Water near the Root, and the higher it went, the more different, and the more alter'd it would be; but we find the Sap at the Bottom and Top of a Plant to be the ſame, and as full of Spirit at the Bottom, which could not be ſuppoſed to be made in ſo ſhort a Percolation, if by Percolation at all.

If Leaves did not perform this neceſſary work of Succification, the Lives of Plants would not, in all probability, ſo entirely depend on the uſe of Leaves, as they appear to do. And this is always found

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poſing that Liquor to be Sap; which I think almoſt as unreaſonable as to ſuppoſe, the Wine we drink and piſs out, to be Blood; The more we drink the quicker the Liquor will generally paſs; and the Man, who drank and piſs'd out a large Veſſel at one Draught, without taking his Mouth from the Tap, 'till 'twas finiſhed, had as quick a Paſſage for Liquor, as any Plant in all Mr. *Hale*'s Experiments, and yet is no proof againſt the Circulation of the Blood,

Vide Mr. *Hale* of Vegetation, pag. 324, 325, where he ſays, That 'tis probable Dew, Rain, *&c.* are imbibed by the Leaves, and are the Materials of which the more ſubtile and refined Principles are form'd. And alſo, That Leaves do in ſome Meaſure, the ſame Office for the Support of Vegetable Life, that Lungs do for the Support of the Animal Life; Plants drawing through their Leaves ſome part of their Nouriſhment from the Air.

If this Nutritive Matter did enter at the excretory Ducts of Leaves, while the Plant was in an imbibing State (as he ſeems to think) then they muſt be expelled again at the ſame Ducts, by the force of the perſpiring Stream, as ſoon as the perſpiring State returns; and thus could be of little or no uſe to the Sap, not going far in.

And is it not more probable, that the Sulphureo-Aerial Particles which, he proves, are ſo plentifully in Leaves, ſhould invigorate the pure Sap returning into the Plant, than to invigorate only that Recrementitious Sap, that is juſt making its Exit at the excretory Ducts? How could this invigorate the Plant, or help to nouriſh it?

true (tho' too late) by thoſe who kill their *St. Foin*, by ſuffering it to be indiſcreetly fed by Sheep: And to caution them againſt that Injury, is the Reaſon of my writing this Chapter.

Leaves being ſo neceſſary, Nature has, in all Perennial Plants, provided a Reverſionary Stock of them; wherefore Leaves are always form'd, as Dr. *Grew* obſerves, in Autumn, tho' they are not uſually explain'd 'till the following Spring, which then open and increaſe gradually, in proportion to the Motion of the Sap, and Quantity of *Pabulum* it then receives to be circulated.

Theſe may alſo, tho' not wholly appearing out of the Bud, be ſufficient for the extream ſmall Motion of Life, the Sap of Perennial Plants, which drop their Leaves, have in Winter.

Beſides theſe Autumnal Leaves of Dr. *Grew*'s, there is another Sett of them, form'd in the Spring, which appear and are explain'd about Mid-ſummer; theſe ſave the Lives of the Mulberry-trees, when the firſt Leaves are taken off for the Food of Silkworms; but theſe ſecond Leaves alone would not ſuffice to purify the Sap, or ſave the Trees, if the firſt Leaves were ſtripp'd off downwards; but as thoſe who gather them, pull and ſtrip them upwards, there always remain ſome of the Tails, or Foot-ſtalks, with a little part of the Leaves, behind unpull'd; by help of which remaining parts, the Trees make a ſhift to live for ſome time, 'till the new Leaves grow large enough: As Men have been found to have Lived (but not long I ſuppoſe) by a ſmall Part of their Lungs, the reſt having been waſted, and dry'd away in Conſumptive or Aſthmatical Caſes.

This is certain from all Experience, that no Vegetable whatever can live long without Leaves, but will very ſoon die, if the Leaves are pull'd off as faſt as they appear.

The Reaſon why natural Graſs may ſeem an Exception to this is, that when 'tis fed by Cattle, there is never any great Quantity of it (eſpecially of Stalks) growing at once, and ſo leſs Sap to be purify'd; and has not only a greater proportion of Leaves, but alſo many Succeſſions of them, ſtill ready to ſupply the loſs of thoſe that are eaten; and many of theſe Leaves are ſo ſmall, ſhort and low, that the Cattle cannot come at them to Bite them off cloſe; many more alſo come out of the very Roots of natural Graſs.

CHAP. III. *Of* FOOD *of* PLANTS.

THE chief Art of a Husbandman is to feed Plants to the beſt Advantage; but, how ſhall he do that, unleſs he knows what is their Food? By Food is meant that Matter, which being added and united to the firſt *Stamina* of Plants, or *Plantulæ*, which were made in little at the Creation, gives them, or rather is their Increaſe.

'Tis agreed, that all the following Materials contribute, in ſome manner, to the Increaſe of Plants, but 'tis diſputed which of them is that very Increaſe or Food. 1. *Nitre*. 2. *Water*. 3. *Air*. 4. *Fire*. 5. *Earth*.

I will not mention, as a Food, that acid Spirit of the Air, ſo much talk'd of; ſince by its eating aſunder Iron Bars, it appears too much of the nature of *Aqua Fortis*, to be a welcome Gueſt alone to the tender Veſſels of the Roots of Plants.

Nitre is uſeful to divide and prepare the Food, and may be ſaid to nouriſh Vegetables in much the ſame manner as my Knife nouriſhes me, by cutting and dividing my Meat: But when *Nitre* is apply'd to the Root of a Plant, it will kill it as certainly as a Knife miſapply'd will kill a Man; which proves, that *Nitre* is, in reſpect of Nouriſhment, juſt as much the Food of Plants, as *white Arſenick* is the Food of Rats. And the ſame may be ſaid of Salts.

Water, from *Van-Helmont's* Experiment, was by ſome great Philoſophers thought to be it. But theſe were deceived, in not obſerving that Water has always in its intervals a charge of Earth, from which no Art can free it. This Hypotheſis having been fully confuted by Dr. *Woodward*, No-body has, that I know of, maintain'd it ſince: And to the Doctor's Arguments I ſhall add more in the Article of Air.

Air, becauſe its Spring, *&c.* is as neceſſary to the Life of Vegetables, as the Vehicle of Water is; ſome modern Virtuoſi have affirm'd, from the ſame and worſe Arguments, than thoſe of the Water-Philoſophers, that Air is the Food of Plants. Mr. *Bradley*, being the chief, if not only Author, who has publiſh'd this Phantaſie, which at preſent ſeems to get ground; 'tis fit he ſhould be anſwer'd, and this will be eaſily done, if I can ſhew, that he has anſwer'd this his own Opinion, by ſome or all of his own Arguments.

His firſt is, that of *Helmont*, and is thus related in Mr. *Bradley's* general Treatiſe of *Husbandry and Gardening*, Vol. 1. P. 36. ‘Who dry'd two Hun-
‘dred Pounds of Earth, and Planted a Willow of
‘Five Pounds weight in it, which he water'd with
‘Rain, or diſtill'd Water; and to ſecure it from a-
‘ny other Earth getting in, he cover'd it with a
‘perforated Tin Cover. Five Years after, weigh-
‘ing the Tree, with all the Leaves it had born in
‘that Time, he found it to weigh One Hundred
‘Sixty-Nine Pounds Three Ounces; but the Earth

‘ was only diminiſh’d about Two Ounces in its ‘ weight.

On this Experiment Mr. *Bradley* grounds his Airy Hypotheſis. But let it be but examined fairly, and ſee what may be thence inferr’d.

The Tin Cover was to prevent any other Earth from getting in. This muſt alſo prevent any Earth from getting out, except what enter’d the Roots, and by them paſs’d into the Tree.

A Willow is a very thirſty Tree, and muſt have drank in Five Years time ſeveral Tuns of Water, which muſt neceſſarily carry in its Interſtices a great Quantity of Earth (probably many times more than the Tree’s weight (*), which could not get out, but by the Roots of the Willow.

Therefore the Two Hundred Pound of Earth not being encreaſed, proves that ſo much Earth as was poured in with the Water, did enter the Tree.

Whether the Earth did enter to nouriſh the Tree, or whether only in order to paſs through it (by way of Vehicle to the Air) and leave the Air behind for the Augment of the Willow, may appear by examining the Matter of which the Tree did conſiſt.

If the Matter remaining after the Corruption or Putrefaction of the Tree, be Earth, will it not be a Proof, that the Earth remained in it, to nouriſh and augment it, for it could not leave what it did not firſt take, nor be augmented by what paſſed thro’ it? According to *Ariſtotle*’s Doctrine, and Mr. *Bradley*’s too, in Vol. 1. p. 72. “ Putrefaction reſolves it a“ gain into Earth, its firſt Principle.

The Weight of the Tree, even when Green, muſt conſiſt of Earth and Water. Air could be no part

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(*) The Body of an Animal receives a much leſs Increaſe in Weight than its Perſpirations amount to, as *Sanctorius*’s *Statick-Chair* Demonſtrates.

of it, becauſe Air being of no greater ſpecifick Gravity than the incumbent Atmoſphere, could not be of any weight in it; therefore was no part of the One Hundred Sixty Nine Pounds Three Ounces.

Nature has directed Animals and Vegetables to ſeek what is moſt neceſſary to them.

At the time when the *Fœtus* has a Neceſſity of Reſpiration, 'tis brought forth into the open Air, and then the Lungs are filled with Air. As ſoon as a Calf, Lamb, *&c.* is able to ſtand, it applies to the Teat for Food, without any Teaching. In like Manner Mr. *Bradley* remarks, in his Vol. 1. pag. 10. ' That almoſt every Stem and every Root are form-' ed in a bending Manner under Ground, and yet all ' theſe Stems become ſtrait and upright when they ' come above Ground, and meet the Air; and moſt ' Roots run as directly downwards, and ſhun the ' Air as much as poſſible.

Can any thing more plainly ſhew the Intent of Nature, than this his Remark does, *viz.* That the Air is moſt neceſſary to the Tree above Ground, to purify the Sap by the Leaves, as the Blood of Animals is depurated by their Lungs? And that Roots ſeek the Earth for their Food, and ſhun the Air, which would dry up and deſtroy them?

No one Truth can poſſibly contradict or interfere with any other Truth; but one Error may contradict and interfere with another Error, *viz.*

Mr. *Bradley* and all Authors, I think, are of Opinion, that Plants of different Natures, are fed by a different ſort of Nouriſhment; from whence they aver, that a Crop of Wheat takes up all that is peculiar to that Grain; Then a Crop of Barley all that is proper to it; next a Crop of Peaſe, and ſo on, till each has drawn off all thoſe Particles which are proper to it; and then no more of theſe Grains will grow in that Land, 'till by Fallow, Dung, and Influences of the Heavens, the Earth will be again repleniſh'd with new Nouriſhment, to ſupply the ſame ſorts of Corn over again. This if true (as they all affirm it to be) would prove, that the Air is not the Food of Vegetables. For the Air being in itſelf ſo Homogeneous as it is, could never afford ſuch different Matter as they imagine, neither is it probable, that the Air ſhould afford the Wheat, Nouriſhment more one Year, than the enſuing Year. Or that the ſame Year it ſhould nouriſh Barley in one Field, Wheat in another, Peaſe in a Third, but that if Barley were ſown in the Third, Wheat in the Firſt, Peaſe in the Second, all would fail. Therefore this Hypotheſis of Air for Food, interferes with, and contradicts this Doctrine of Neceſſity of changing Sorts.

I ſuppoſe, by Air, they do not mean dry Particles of Earth, and the Effluvia which float in the Air, the Quantity of theſe is too ſmall to augment Vegetables to that Bulk they arrive at. By that way of ſpeaking they might more truly affirm this of Water, becauſe it muſt be like to carry a greater Quantity of Earth, than Air doth, in proportion to the difference of their different ſpecifick Weight; Water being about 800 times heavier than Air, is likely to have 800 times more of that Terreſtrial Matter in it; and we ſee this is ſufficient to maintain ſome ſorts of Vegetables, as Aquaticks. But the Air, by its charge of Effluvia, *&c.* is never able to maintain or nouriſh any Plant; for as to the Sedums, Aloes, and all others, that are ſuppos'd to grow ſuſpended in the Air, 'tis a meer fallacy; they ſeem to grow, but do not; ſince they conſtantly grow lighter, and tho' their Veſſels may be ſomewhat diſtended, by the ferment of their own Juices, which they received in the Earth, yet ſuſpended in Air, they continually diminiſh in Weight (which is the true augment of a Plant) until they grow to no-

nothing. So that this Inſtance of Sedums, *&c.* which they pretend to bring for Proof of this their Hypotheſis, is alone a full Confutation of it.

Yet if granted, that Air could nouriſh ſome Vegetables by the earthy Effluvia, *&c.* which it carry'd with it (*), even that would be againſt them, not for them.

They might as well believe, that *Martins* and *Swallows* are nouriſh'd by the Air, becauſe they live on Flies and Gnats, which they catch therein; this being the ſame Food, which is found in the Stomach of the Chamelion.

If, as they ſay, the Earth is of little other uſe to Plants, but to keep them fix'd and ſteady, there would be little or no difference in the Value of Rich and Poor Land, Dung'd or Undung'd; for one would ſerve to keep Plants fix'd and ſteady, very near, if not quite as well as the other.

If Water or Air was the Food of Plants, I cannot ſee what neceſſity there ſhould be of Dung or Tillage.

4. *Fire.* No Plant can live without Heat, tho' different degrees of it be neceſſary to different ſorts of Plants. Some are almoſt able to keep Company with the *Salamander*, and do live in the hotteſt expoſures of the hot Countries. Others have their abode with Fiſhes under Water, in cold Climates: for the Sun has his Influence, tho' weaker upon the Earth cover'd with Water, at a conſiderable Depth, which appears by the Effect the viciſſitudes of Winter and Summer have upon Subterraqueous Vegetables.

(*) This is meant of dry Earth, by its lightneſs (when Pulveriz'd extremely fine) carried in the Air without Vapour: For the Atmoſphere, conſiſting of all the Elements, has Earth in it in a conſiderable Quantity, mixt with Water; but a very little Earth is ſo minutely divided, as to fly therein pure from Water, which is its Vehicle there for the moſt part.

But, That Fire is the Food of Plants, I don't know any Author has affirm'd, except Mr. *Laurence*, who ſays, " They are true Fire-Eaters. And even he does not ſeem to intend, that this Expreſſion of his ſhould be taken literally; yet if he had meant it in the plain Senſe the Words import, perhaps he might have been much nearer the Truth than Mr. *Bradley* with his Air. For if Fire be nothing elſe but the minuteſt parts of Terreſtrial Matter, put into a violent Motion, then thoſe minute parts out of that Motion are the ſame Matter as when in it; and theſe being the true Nouriſhment of Plants, That and Fire differ in nothing but the Motion.

Fire is a fluid *ſui Generis*; but that it pervades all Bodies, and there remains latent; if excited by Violence is Hot; if at Reſt may be Cold, being againſt the eſſential property of Fire: That Notion cannot pervade the Skull of a Peaſant to make him believe, Fire can ever be cold.

But if we define Fire to be the Action of Burning, not the Matter which Burns, then Fire will be as different from the Food of Plants, as Air is.

Indeed the true Food of Plants may be alſo the fuel of Fire, which is ſo greedy of that Food, as to carry it all away that comes within reach of the Flames; and I know no way, by which the Earth can be diveſted of its vegetative Particles, but by actual Fire, or the Roots of Plants.

Tho' every heat is ſaid to be a different degree of Fire, yet we may diſtinguiſh the degrees by their different effects. Heat warms, but Fire burns; the firſt helps to cheriſh, the latter deſtroys Plants.

5. *Earth.* That which nouriſhes and augments a Plant, is the true Food of it.

Every Plant is Earth, and the growth and true increaſe of a Plant is the Addition of more Earth.

Nitre (or other Salts) prepares the Earth, Water and Air move it, by conveying and fermenting it in the Juices, and this motion is called Heat.

When this additional Earth is aſſimilated to the Plant, it becomes an abſolute part of it.

Suppoſe Water, Air, and Heat, could be taken away, would it not remain to be a Plant, though a Dead one?

But ſuppoſe the Earth of it taken away, what would then become of the Plant; Mr. *Bradley* might look long enough after it, before he found it in the Air amongſt his ſpecifick or certain Qualities.

Beſides, too much *Nitre* (or other Salts) corrodes a Plant; too much Water drowns it; too much Air dries the Roots of it; too much Heat (or Fire) burns it; but, too much Earth, a Plant never can have, unleſs it be therein wholly buried; and in that Caſe it would be equally miſapply'd to the Body, as Air or Nitre would be to the Roots.

Too much Earth, or too Fine, can never poſſibly be given to Roots; for they never receive ſo much of it, as to ſurfeit the Plant, unleſs it be depriv'd of Leaves, which, as Lungs, ſhould purify it.

And Earth is ſo ſurely the Food of all Plants, that with the proper ſhare of the other Elements, which each Species of Plants requires, I do not find but that any common Earth will nouriſh any Plant.

The only Difference of Soil (except the Richneſs) ſeems to be the different Heat and Moiſture it has; for if thoſe be rightly adjuſted, any Soil will nouriſh any ſort of Plant. For let *Thyme* and *Ruſhes* change places, and both will Die; but let them change their Soil, by removing the Earth wherein the *Thyme* grew, from the dry Hill down into the watry Bottom, and plant *Ruſhes* therein; and carry the moiſt Earth, wherein the *Ruſhes* grew, up to the Hill; and there *Thyme* will grow in the Earth that was taken from the *Ruſhes*; and ſo will the *Ruſhes* grow in the Earth that was taken from the *Thyme*; ſo that 'tis only more or leſs Water that makes the ſame Earth fit either for the growth of *Thyme* or *Ruſhes*.

So for Heat; our Earth, when it has in the Stove the juſt degree of Heat, that each ſort of Plants requires, will maintain Plants brought from both the *Indies*.

Plants differ as much from one another in the degrees of Heat and Moiſture, as a Fiſh differs from a Salamander.

Indeed *Miſletoe* will not live upon Earth, until it be firſt alter'd by the Veſſels of a Tree, and therein is as nice in Food as an Animal.

There is no need to have recourſe to Tranſmutation; for whether Air or Water, or both, are Transform'd into Earth or not, the thing is the ſame, if it be Earth when the Roots take it; and we are convinced that neither Air nor Water alone, as ſuch, will maintain Plants.

Theſe kind of Metamorphoſes may properly enough be conſider'd in Diſſertations purely concerning Matter, and to diſcover what the Component Particles of Earth are; but not at all neceſſary to be known, in relation to the maintaining of Vegetables.

CHAP. IV. *Of* PASTURE *of* PLANTS.

CATTLE feed on Vegetables that grow upon the Earth's external Surface; but Vegetables themſelves firſt receive, from within the Earth, the Nouriſhment they give to Animals.

The Paſture of Cattle has been known, and underſtood in all Ages of the World, it being liable to Inſpection; but the Paſture of Plants, being out of the Obſervation of the Senſes, is only to be known by Diſquiſitions of Reaſon, and has (for ought I can find) paſt undiſcover'd by the Writers of Husbandry (1).

The Ignorance of this ſeems to be one Principal Cauſe, that Agriculture, the moſt neceſſary of all Arts, has been treated of by Authors more ſuperficially than any other Art whatever. The Food, or Pabulum of Plants being prov'd to be Earth, where, and whence (2) they take that, may properly be called their Paſture.

This Paſture I ſhall endeavour to deſcribe.

'Tis the inner, (or internal) Superficies (3) of the Earth

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(1) When Writers of Husbandry, in diſcourſing of Earth, and Vegetation, come neareſt to the Thing, that is, the *Paſture* of *Plants*, they are loſt in the Shadow of it, and wander in a Wilderneſs of obſcure Expreſſions, ſuch as *Magnetiſm*, *Virtue*, *Power*, *Specifick Quality*, *Certain Quality*, and the like, wherein there is no manner of Light, for diſcovering the real Subſtance; but we are left by them more in the Dark to find it, than Roots are when they feed on it. And when a Man, no leſs ſagacious than Mr. *Evelyn*, has traced it through all the *Mazes* of the *Occult Qualities*, and even up to the *Metaphyſicks*, he declares, he cannot determine whether the Thing he purſues be *Corporeal*, or *Spiritual*.

(2) By the Paſture is not meant the *Pabulum* it ſelf; but the *Superficies* from whence the *Pabulum* is taken by Roots.

(3) This Paſture of Plants nev'er having been mentioned, or deſcribed by any Author that I know of, I am at a loſs to find any other Term to deſcribe it by, that may be Synonymous, or æquipollent to it; therefore for want of a better, I call it the inner, or internal Superficies of the Earth, to diſtinguiſh it from the outer, or external Superficies, or Surface whereon we tread.

Inner, or internal Superficies, may be thought an abſurd Expreſſion, the Adjective expreſſing ſomething within, and the Subſtantive ſeeming to expreſs only what is without it; and indeed, Earth, or which is the ſame thing, 'tis the Superficies of the Pores, Cavities, or Interſtices of the divided parts of the Earth, which are of two Sorts, *viz. Natural* and *Artificial*.

By Nature, the whole Earth, (or Soil) is compoſed of Parts, and if theſe had been in every Place abſolutely joined, it would have been without Interſtices or Pores, and would have had no Internal Superficies, or Paſture for Plants; but ſince it is not ſo ſtrictly Denſe, (4) there muſt be Interſtices at all thoſe Places where the Parts remain ſeparate and divided.

Theſe Interſtices by their Number, and Largeneſs, determine the Specifick Gravity (or true Quantity) of every Soil, the larger they are, the lighter is the Soil; and the Inner Superficies is commonly the Leſs.

The Mouths, or Lacteals, being ſituate, and opening in the Convex Superficies of Roots, they take their pabulum, being fine Particles of Earth, from the Superficies of the Pores, or Cavities, wherein the Roots are included.

And 'tis certain, that the Earth is not diveſted, or robb'd of this Pabulum, by any other Means, than by actual Fire, or the Roots of Plants.

For when no Vegetables are ſuffer'd to grow in a

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indeed, the Senſe of the Expreſſion is ſo; for the Vegetable Paſture is within the Earth, but without (or on the outſides of) the divided parts of the Earth.

And beſides Superficies muſt be joined with the Adjective Inner, (or Internal) when 'tis uſed to deſcribe the inſide of a thing that is hollow, as the Pores and Interſtices of the Earth are.

The Superficies, which is the Paſture of Plants, is not a bare mathematical Superficies, for that is only imaginary.

(4) For were the Soil as denſe as Glaſs, the Roots of Vegetables (ſuch as our Earth produces) would never be able to enter its Pores.

Soil, it will always grow Richer. Plow it, Harrow it, as often as you pleaſe, expoſe it to the Sun in Horſe-Paths all the Summer, and to the Froſt of the Winter; let it be cover'd by Water at the Bottom of Ponds, or Ditches, or if you Grind dry Earth to Powder, the longer 'tis kept expoſed, or treated by theſe or any other Method poſſible, (except actual Burning by Fire) inſtead of Loſing, it will gain the more Fertility.

Theſe Particles, which are the Pabulum of Plants, are ſo very Minute (5) and Light, as not to be ſingly attracted to the Earth, if ſeparated from thoſe Parts to which they adhere, (6) or with which they are in contact, (like Duſt to a Looking-Glaſs, turn it upwards, or downwards, it will remain affixt to it) as theſe Particles do to thoſe Parts, until from thence remov'd by ſome Agent.

A Plant cannot ſeparate theſe Particles from the Parts to which they adhere, without the Aſſiſtance of Water, which helps to looſen them.

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(5) As to the fineneſs of the Pabulum of Plants, 'tis not unlikely that Roots may inſume no groſſer Particles, than thoſe on which the Colours of Bodies depend; but to diſcover the greateſt of thoſe Corpuſcles, Sir *Iſaac Newton* thinks will require a Microſcope, that with ſufficient Diſtinctneſs can repreſent Objects five or ſix hundred times bigger, than at a Foot Diſtance they appear to the naked Eye.

My Microſcope is indeed but a very ordinary one, and when I view with it the Liquor newly imbibed by a Fibrous Root of a Mint, it ſeems more limpid than the cleareſt common Water, nothing at all appearing in it.

(6) Either Roots muſt inſume the Earth, that is their Pabulum, as they find it in whole Pieces, having entire Superficies of their own, or elſe ſuch Particles as have not entire Superficies of their own, but want ſome part of it, which adheres to, or is part of the Superficies of larger Particles, before they are ſeparated by Roots. The former they cannot inſume, (unleſs contained in Water) becauſe they would fly away at the firſt Pores that were open: Ergo they muſt inſume the latter.

And 'tis alſo probable, that the Nitre of the Air may be neceſſary to relax this Superficies, to render the Prolifick Particles capable of being thence diſjoin'd; and this Action of the Nitre, ſeems to be what is call'd, Impregnating the Earth.

Since the groſſer Vegetable Particles, when they have paſs'd thro' a Plant, together with their moiſt Vehicle, do fly up into the Air inviſibly; 'tis not likely they ſhould, in the Earth, fall off from the Superficies of the Pores, by their own Gravity. And if they did fall off, they might fly away as eaſily before they enter'd Plants, as they do after they have paſs'd thro' them; and then a Soil might become the poorer, (1) for all the Culture and Stirring we beſtow upon it, tho' no Plants were in it, contrary to Experience.

It muſt be own'd, that Water does ever carry in its Interſtices, Particles of Earth, fine enough to enter Roots; becauſe I have ſeen, that a great Quantity of Water, (in my Experiments) will paſs out of Roots ſet in Rain Water; and 'tis found that Water can never be, by any Art, wholly freed from its earthy Charge; therefore it muſt have carry'd in ſome particles of Earth along with it; but yet, I cannot hence conclude, that the Water did firſt take theſe fine Particles from the aforeſaid Superficies: I rather think, that they are Exhal'd, together with very ſmall Pieces to which they adhere, and in the Vapour divided by the Aerial Nitre, and when the Vapour is condens'd, they deſcend with it to repleniſh the Paſture of Plants; and that theſe do not enter entire into Roots, neither does any other of the Earthy Charge that any Water contains; Except ſuch fine Particles which have already paſs'd thro' the Vegetable Veſſels, and been thence Exhal'd.

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(1) But we ſee it is always the richer by being frequently turned and expoſed to the Atmoſphere: Therefore Plants muſt take all their Pabulum from a Superficies of Parts of Earth; except what may perhaps be contained in Water fine enough to enter Roots entire with the Water.

This Conjecture is the more probable, for that Rain-Water is as nouriſhing to Plants ſet therein, as Spring-Water, tho' the latter have more Earth in it, and tho' Spring-Water have ſome Particles in it, that will enter Entire into Roots, yet we muſt conſider, that even That Water may have been many times exhal'd into the Air, and may have ſtill retain'd a great Quantity of Vegetable Particles, which it received from Vegetable Exhalations in the Atmoſphere, tho' not ſo great a Quantity, as Rain-Water, that comes immediately thence.

Theſe, I have to do with, are the Particles which Plants have from the Earth, or Soil; but they have alſo fine Particles of Earth from Water, which may impart ſome of its fineſt Charge to the Superficies of Roots, as well as to the Superficies of the Parts of the Earth, (2) which makes the Paſture of Plants.

Yet it ſeems, that much of the Earth contain'd in the cleareſt Water, is there in too large Parts to enter a Root; ſince we ſee that in a ſhort time the Root's Superficies, will in the pureſt Water, be cover'd with Earth, which is then form'd into a terrene Paſture, which may nouriſh Roots; but very few Plants will live long in ſo thin a Paſture, as any Water affords them. I cannot find one as yet, that has liv'd a Year, without ſome Earth have been added to it.

And all Aquaticks that I know, have their Roots in the Earth, tho' cover'd with Water.

The Pores, Cavities, or Interſtices of the Earth, being of two Sorts, *viz. Natural* and *Artificial*; the one affords the Natural, the other the Artificial Paſture of Plants.

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(2) If Water does ſeparate, and take any of the mere Pabulum of Plants from the Soil, it gives much more to it.

The natural Paſture alone will ſuffice, to furniſh a Country with Vegetables, for the Maintenance of a few Inhabitants; but if Agriculture were taken out of the World, 'tis much to be fear'd, that thoſe of all populous Countries, eſpecially towards the Confines of the frigid Zones, (for there the Trees often fail of producing Fruit,) would be oblig'd to turn Anthropophagi, as in many uncultivated Regions they do, very probably for that Reaſon.

The Artificial Paſture of Plants, is that inner Superficies, which is made from dividing the Soil by Art.

This does, on all Parts of the Globe where uſed, maintain many more People than the Natural Paſture; (1) and in the colder Climates, I believe, it will not be extravagant to ſay, Ten times as many: or, that in caſe Agriculture were a little Improved (as I hope to ſhew is not difficult to be done) it might maintain twice as many more yet, or the ſame Number better.

The Natural Paſture, is not only leſs than the Artificial, in an equal Quantity of Earth; but alſo, that little conſiſting in the Superficies of Pores, or Cavities, not having a free Communication (2) with one another, are leſs pervious to the Roots of all

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(1) The extraordinary Increaſe of St. Foin, Clover, and Natural Graſs, when their Roots reach into pulveriz'd Earth, exceeding the Increaſe of all thoſe other Plants of the ſame Species (that ſtand out of the reach of it) above One Hundred times, ſhew how vaſtly the Artificial Paſture of Plants, exceeds the Natural.

(2) None of the Natural Vegetable Paſture is loſt, or injured by the Artificial, but on the contrary, 'tis mended, by being mix'd with it, and by having a greater Communication betwixt Pore and Pore.

Vegetables, and which require a greater Force to break through their Partitions; by that means, Roots, eſpecially of weak Plants, are excluded from many of thoſe Cavities, and ſo loſe the Benefit of them.

But the Artificial Paſture conſiſts in Superficies of Cavities, that are pervious to all manner of Roots, and that afford them free Paſſage and Entertainment in, and thro' all their Receſſes. Roots may here extend to the Utmoſt, without meeting with any Barricadoes in their Way.

The Internal Superficies, which is the natural Paſture of Plants, is like the external Superficies, or Surface of the Earth, whereon is the Paſture of Cattle; in that it cannot be enlarg'd without Addition of more Surface taken from Land adjoining to it, by enlarging its Bounds or Limits.

But the Artificial Paſture of Plants may be enlarged, without any Addition of more Land, or Enlarging of Bounds, and this by Diviſion only of the ſame Earth.

And this Artificial Paſture may be increas'd in Proportion to the Diviſion of the Parts of Earth, whereof it is the Superficies, which Diviſion may be mathematically Infinite; for an Atom is Nothing; neither is there a more plain Impoſſibility in Nature, than to reduce Matter to Nothing, by Diviſion or Separation of its Parts.

A Cube of Earth of One Foot, has but Six Foot of Superficies. Divide this Cube into Cubical Inches, and then its Superficies will be increas'd Twelve Times, *viz.* to Seventy two Superficial Foot. Divide theſe again in like manner, and proportion, that is, Divide them into Parts that bear the ſame Proportion to the Inches, as the Inches do to the Foot; and then the ſame Earth, which had at firſt no more than Six Superficial Foot, will have Eight Hundred

Sixty-four Superficial Foot of Artificial Paſture, and ſo is the Soil Diviſible, and this Paſture increaſible *ad Infinitum*.

Poor Land does not afford an Internal Superficies, ſo well ſtock'd with theſe fruitful Particles, as rich Land doth, but this we may compenſate by *Dividing* it more; to the End that what this Artificial Paſture wants in Quality, may by Diviſion be made up in Quantity.

The common Methods of Dividing the Soil, are theſe, *viz.* by *Dung*, by *Tillage*, or by both (3).

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(3) For *Vis Unita Fortior.*

CHAP. V. *Of DUNG.*

ALL ſorts of *Dung* and *Compoſt* contain ſome Matter, which, when mixt with the Soil, ferments therein; and by ſuch Ferment diſſolves, crumbles, and divides the Earth very much; This is the chief, and almoſt only Uſe of *Dung*: For as to the pure earthy Part of it, the Quantity is ſo very ſmall, that, after a perfect Putrefaction, it appears to bear a moſt inconſiderable Proportion to the Soil it is deſign'd to Manure; and therefore, in that reſpect, is next to nothing.

Its fermenting Quality is chiefly owing to the Salts wherewith it abounds, but a very little of this Salt applied alone to a few Roots of almoſt any Plant will (as, in my *Mint* Experiments, it is evident common Salt does) kill it.

This proves, that its uſe is not to nouriſh, but to diſſolve, *i. e.* Divide the Terreſtrial Matter, which affords Nutriment to the Mouths of vegetable Roots.

It is, I ſuppoſe, upon the account of the acrimonious fiery Nature of theſe Salts, that the Floriſts have baniſh'd Dung from their Flower-Gardens.

And there is, I'm ſure, much more reaſon to prohibit the uſe of *Dung* in the Kitchen-Garden, on account of the ill taſte it gives to Eſculent Roots, and Plants, eſpecially ſuch Dung as is made in great Towns.

'Tis a Wonder how delicate Palates can diſpenſe with eating their Own, and their Beaſt's Ordure, but a little more putrify'd and evaporated; together with all ſorts of Filth and Naſtineſs, a Tincture of which thoſe Roots muſt unavoidably receive, that grow amongſt it.

Indeed I do not admire, that learned Palates, accuſtom'd to the *Goût* of *Silphium*, *Garlick*, *la Chair venee*, and mortify'd Veniſon, equalling the Stench and rankneſs of this ſort of City-Muck, ſhould reliſh and approve of Plants that are fed and fatted by its immediate Contact.

People who are ſo vulgarly Nice, as to nauſeate theſe modiſh Dainties, and whoſe ſqueamiſh Stomachs even abhor to receive the Food of Nobles, ſo little different from that wherewith they regale their richeſt Gardens, ſay, that even the very Water, wherein a rich Garden-Cabbage is boil'd, Stinks; but that the Water, wherein a Cabbage from a poor undung'd Field is boil'd, has no manner of unpleaſant Savour; and that a *Carrot*, bred in a Dunghil, has none of that ſweet reliſh, which a Field-Carrot affords.

There is a like difference in all Roots, nouriſh'd with ſuch different Diet.

Dung, not only ſpoils the fine Flavour of theſe our Eatables, but inquinates good Liquor. The dung'd Vineyards in *Languedoc*, produce nauſeous Wine, from whence there is a Proverb in that Country, That poor People's Wine is beſt, becauſe they carry no *Dung* to their Vineyards.

Dung is obſerv'd to give great Encouragement to the Production of Worms; and Carrots in the Garden are much Worm-eaten, when thoſe in the Field are free from Worms.

Dung is the Putrefaction of Earth, after it has been alter'd by vegetable, or Animal Veſſels.

Vegetable Dung, unleſs the Vegetable be buried alive in the Soil, makes a much leſs Ferment in it, and conſequently divides it leſs, than Animal Dung does.

But the Dung of Vegetables is much more wholeſom for the uſe of Edible Roots and Plants, than that of Animals is.

The very Effluvia of Animal Bodies, ſent off by Perſpiration, are ſo noxious, as to kill the Animal that emits them, if confin'd to receive them back in great Quantity, by breathing in an Air replete with them, which appears from the ſoon dying of an Animal ſhut up in a Receiver full of Air. Yet this ſeems to be moſt harmleſs of all ſorts of Animal Excrements the Air can be infected with. How obnoxious then muſt be the more fetid Steams of Ordure?

If a Catalogue were publiſh'd of all Inſtances from Charnel-Houſes (or Cemeteries) and of the Peſtiferous Effects, which have happen'd from the Putrefaction of dead Bodies, after great Battles, even in the open Air, No-body, I believe, would have a good Opinion of the wholeſomneſs of Animal Dung; for if a great Quantity do ſo infect the Air, 'tis likely a leſs may infect it in Proportion to that leſs Quantity.

In great Cities the Air is full of theſe Effluvia, which in hot Climes often produce the Peſtilence; and in cold Climes, People are generally obſerv'd to live a leſs time, and leſs healthfully in Cities, than in the Country; to which difference, 'tis likely, that the eating unwholeſom Gardenage may contribute.

This Dung is a fitter Food for venomous Creatures (1) than for Edible Plants, and 'tis (no doubt) upon account of this, that dung'd Gardens are ſo much frequented by Toads, which are ſeldom or never ſeen, in the open undung'd Fields.

Some have loſt their Lives by Toads, being accidentally boil'd in the folds of a Loaf-Cabbage, others poiſon'd by their only fixing their Claws on their Arm. A Mountebank, to ſhew the Energy of his Antidotes, uſed to eat part of a Toad on his Stage, and cure himſelf by his Medicines; but I was told by one, that one ſaw him in his Chamber (after eating too large a Doſe of the Poiſon, or elſe delaying too long the Application of his Remedy) in ſuch a diſmal Condition, that his Life was deſpair'd of, tho' with much difficulty, and ſome time, he recover'd.

And notwithſtanding what ſome Authors have ſaid of the Innoxiouſneſs of this Animal, theſe and other Inſtances perſwade me, that Nature did not give moſt People ſuch an Averſion to it, in vain. It may not be mortal to every human Body, ſince I am told of a Man, that has eaten ſeveral Toads without any apparent Injury to him; but, I believe, moſt who ſhall try the Experiment, will be forc'd to confeſs, That what is one Man's Meat, is another's Poiſon.

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(1) Mr. *Evelyn* ſays, that Dung is the Nurſe of Vermin.

What can we ſay then to the Salubrity of thoſe Roots themſelves, bred up and fatten'd amongſt theſe Toads and Corruption? The Leaves indeed are only diſcharging ſome of the Filth, when we eat them; but the Roots have that unſavoury infected Food in their very Mouths, when we take them for our Nouriſhment.

But tho' *Dung* be, upon theſe and other accounts, Injurious to the Garden, yet a conſiderable Quantity of it is ſo neceſſary to moſt Corn-fields, that without it, little good can be done by the old Huſbandry.

Dung is not Injurious to the Fields (1), being there in leſs Proportion: And the Produce of Corn is the Grain; when the Leaves have done their utmoſt to purify the Sap, the moſt refin'd Part is ſecern'd to be yet further elaborated by peculiar Organs; then, by the Veſſels of the Bloſſoms, 'tis become double refin'd for the Nouriſhment of the Grain; which is therefore more pure from Dung, and more wholeſom, than any other part of the Plant that bears it.

And common Tillage alone is not ſufficient for many ſorts of Corn, eſpecially Wheat, which is the King of Grains.

Very few Fields can have the Conveniency of a ſufficient ſupply of Dung, to enable them to produce half the Wheat, thoſe will do near Cities, where they have Plenty of it.

The Crop of 20 Acres, will ſcarce make Dung ſufficient for one Acre, in the common way of Laying it on.

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(1) Such Plants as *Cabbages*, *Turneps*, *Carrots*, and *Potatoes*, when they are deſigned only for Fatting of Cattle, will not be injured by Dung, Tillage, and Hoeing altogether, which will make the Crops the greater, and the Cattle will like them never the worſe.

The Action of the Dung's Ferment affords a warmth (1) to the Infant-plants, in their moſt tender State, and the moſt rigorous Seaſon.

But 'tis hard to know how long the warmth of this Ferment laſteth, by reaſon of the great difficulty to diſtinguiſh the very leaſt degree of Heat, from the very leaſt degree of Cold.

Under the Name of Dung, we may alſo underſtand, whatever ferments with the Earth (except Fire) ſuch as green Vegetables cover'd in the Ground, *&c.*

As to the Difference of the Quantity of Artificial Paſture, made by *Dung* without Tillage, and that made by Tillage without *Dung*; the Latter is many times greater, of which I had the following Proof. An Unplow'd Land, wherein a Dunghill had lain for Two or Three Years, and being taken away, was planted with *Turneps*; at the ſame time a Till'd Land, contiguous thereto, was drill'd with *Turneps*, and Horſe-Ho'd; the other, being Hand-Ho'd, proſper'd beſt at the firſt, but at laſt did not amount to the Fifth part of the Till'd and Horſe-Ho'd, in Bigneſs nor in Crop. The Benefit of the Dung and Hand-Hoe was ſo Inconſiderable, in Compariſon of the Plow and Hoe-Plow; the little Quantity of Artificial Paſture, raiſed to the other, was only near the Surface, and did not reach Deep enough to maintain the *Turneps*, 'till they arrived at the Fifth part of the growth of thoſe, whoſe Artificial Paſture reach'd to the Bottom of the Staple of the Land.

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(1) But though Dung in fermenting may have a little warmth, yet it may ſometimes, by letting more Water enter its Hollowneſs, be in a Froſt much colder than undung'd pulveris'd Earth; for I have ſeen Wheat-Plants in the Winter, die in the very Spits of Dung, when undung'd drill'd Wheat, adjoining to it, planted at the ſame time, has flouriſhed all the ſame Winter; and I could not find any other Reaſon for this, but the Hollowneſs of the Dung, and yet it ſeemed to be well Rotted.

A like Proof is, That ſeveral Lands of *Turneps*, Drill'd on the Level, at Three Foot Rows, Plow'd, and doubly Dung'd, and alſo Horſe-Ho'd, did not produce near ſo good a Crop of *Turneps*, as Six Foot Ridges adjoining, Horſe-Ho'd, tho' no Dung had been laid thereon for many Years. There was no other difference, than that the Three Foot Rows did not admit the Hoe-Plow to raiſe half the Artificial Paſture, as the Six Foot Rows did. The Dung plow'd into the narrow Intervals, before Drilling, could operate no further, with any great effect, than the Hoe-Plow could turn it up, and help it in its Pulveration.

Dung, without Tillage, can do very little; with ſome Tillage doth ſomething; with much Tillage pulverizes the Soil in leſs time, than Tillage alone can do; but the Tillage alone, with more time, can pulverize as well.

I have made many Trials of fine *Dung* on the Rows, and notwithſtanding the Benefit of it, I have, for theſe ſeveral Years laſt paſt, left it off, finding that a little more Hoeing will ſupply it, at a much leſs Expence than that of ſo ſmall a Quantity of Manure, and of the Hands neceſſary to lay it on, and of the Carriage.

Chap. VI. *Of TILLAGE.*

TILLAGE is breaking and dividing the Ground by Spade, Plow, Hoe, or other Inſtruments, which divide by a ſort of Attrition (or Contuſion) as Dung does by Fermentation (1).

By Dung we are limited to the Quantity of it we can procure, which in moſt Places is too ſcanty.

But by Tillage, we can enlarge our Field of Subterranean Paſture without Limitation, tho' the external Surface of it be confin'd within narrow Bounds.

Tillage may extend the Earth's internal Superficies, in proportion to the Diviſion of its Parts, and as Diviſion is Infinite, ſo may that Superficies be.

Every time the Earth is broken by any ſort of Tillage, or Diviſion, there muſt ariſe ſome new Superficies of the broken Parts, which never has been open before: For when the Parts of Earth are once united, and incorporated together, 'tis morally impoſſible that they, or any of them, ſhould be broken again, only in the ſame Places; for to do that, ſuch Parts muſt have again the ſame Numerical Figures, and Dimenſions, they had before ſuch breaking, which even by an infinite Diviſion could never be likely to happen. As the Letters of a Diſtichon, cut out and mixt, if they ſhould be thrown up never ſo often, would never be likely to fall into the ſame Order and Poſition with one another, ſo as to recompoſe the ſame Diſtich.

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(1) *Neque enim aliud eſt Colere quam Reſolvere, & Fermentare Terram.* Columella.

And ſince the Artificial Paſture of Plants is made and increas'd by Pulveration, 'tis no matter whether it be by the Ferment of *Dung*, the Attrition of the *Plow*, the Contuſion of the *Roller*, or by any other Inſtrument, or means whatſoever, except by Fire, which carries away all the Cement of that which is Burnt.

Although the internal Superficies may have been drain'd by a preceding Crop, and the next plowing may move many of the before divided parts, without new breaking them, yet ſuch as are new broken, have at ſuch places where they are ſo broken, a new Superficies, which never was, or did exiſt before; becauſe we cannot reaſonably ſuppoſe, that any of thoſe parts can have in all places (if in any places) the ſame Figure and Dimenſions Twice.

For as the Matter is diviſible *ad Infinitum*, the Places or Lines whereat 'tis ſo diviſible, muſt be in relation to Number infinite, that is to ſay, without Number; and muſt have at every diviſion Superficies of Parts of infinite Variety (2) in figure and dimenſions.

And becauſe 'tis morally Impoſſible, the ſame Figure and Dimenſions ſhould happen Twice, to any one part, we need not wonder, how the Earth every time of Tilling, ſhould afford a new internal Superficies, (or artificial Paſture) and that the Till'd Soil has in it an inexhauſtible Fund, which by a ſufficient Diviſion, (being capable of an Infinite one) may be produc'd.

Tillage (as well as Dung) is beneficial to all ſorts of Land (3). Light Land being naturally Hollow, has larger Pores, which are the cauſe of its Lightneſs.

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(2) Their Variety is ſuch, that 'tis next to Impoſſible, any Two Pieces, or Clods, in a Thouſand Acres of Till'd Ground, ſhould have the ſame Figure, and equal Dimenſions, or that any Piece ſhould exactly Tally with any other, Except with that from whence it was broken off.

(3) 'Tis of late fully prov'd, by the Experience of many Farmers, that Two or Three additional Plowings, will ſupply the place

neſs. This, when it is by any means ſufficiently divided, the parts being brought nearer together, becomes for a Time, Bulk for Bulk, heavier; *i. e.* The ſame Quantity will be contain'd in leſs Room, and ſo is made to partake of the Nature and Benefits of ſtrong Land, *viz.* to keep out too much Heat and Cold, and the like.

But ſtrong Land, being naturally leſs porous, is made for a time lighter, (as well as richer) by a good Diviſion; the ſeparation of its parts makes it more porous, and cauſes it to take up more room, than it does in its natural State, and then it partakes of all the Benefits of lighter Land.

When ſtrong Land is plow'd, and not ſufficiently, ſo that the parts remain groſs, 'tis ſaid to be rough, and it has not the Benefit of Tillage; becauſe

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place of Dung, even in the Old Husbandry, if they be perform'd at proper Seaſons; and the Hiring Price of Three Plowings, after Land has been Thrice plow'd before, is but Twelve Shillings, whereas a Dunging will coſt Three Pounds. This was accidentally diſcover'd in my Neighbourhood, by the Practice of a poor Farmer, who, when he had prepar'd his Land for Barley, and could not procure Seed to ſow it, plow'd it on till Wheat Seed-time, and (by means of ſuch additional plowing) without Dung, had ſo good a Crop of Wheat, that it was judg'd to be worth more than the Inheritance of the Land it grew on.

The ſame Effect follows when they prepare Land for Turneps, ſince they are come in Faſhion, and Sow them ſeveral times upon ſeveral Plowings, the Fly as often taking them off: They have from ſuch Extraordinary Tillage, a good Crop of Wheat, inſtead of the loſt Turneps, without the help of Dung; Hence double plowing is now become frequent in this Country.

The Reaſon why Land is enrich'd by lying long Unplow'd, is, that ſo very few Vegetables are carried off it, very little being produc'd, the Exhauſtion is leſs than what is added by the Atmoſphere, Cattle, *&c.* But when 'tis plow'd, a vaſtly greater Quantity of Vegetables is produc'd and carried off, more than by the Old Husbandry is return'd to it.

cauſe moſt of the Artificial Pores (or Interſtices) are too large, and then it partakes of the Inconveniencies of the hollow Land untill'd.

For when the light Land is plow'd but once, that is not ſufficient to diminiſh its natural Hollowneſs (or Pores) and for want of more Tillage, the parts into which 'tis Divided, by that once, (or perhaps twice) plowing, remain too large, and conſequently the artificial pores are large alſo, and in that reſpect, are like the ill Till'd ſtrong Land.

Light Land having naturally leſs Internal Superficies, ſeems to require the more Tillage, (1) or Dung to enrich it; as when the poor, hollow, thin Downs have their upper part, (which is the beſt) Burnt, whereby all (except a *Caput Mortuum*, or

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(1) As for Puffy Land, which naturally ſwells up, inſtead of ſubſiding, tho' its Hollowneſs is much abated by Tillage, yet is thought little better than Barren Land, and unprofitable for Corn. But what we uſually call Light Land, is only comparatively ſo, in reſpect of that which is heavier, and ſtronger. And this ſort of Light Land becomes much lighter by being ill Till'd; the unbroken pieces of Turf underneath undiſſolved, forming large Cavities, encreaſe its Hollowneſs, and conſequently its Lightneſs: I have often known this ſort of Land deſpis'd by its Owners, who fear'd to give it due Tillage, which they thought would make it ſo light, that the Wind would blow it away; but whenever ſuch has been thoroughly Till'd, it never fail'd to become much ſtronger than before; and conſidering that 'tis Till'd with leſs Expence, than very ſtrong Land, it is, for ſeveral ſorts of Corn, found to be more profitable, than Land of greater Strength, and Richneſs, that is more difficult to be Till'd.

And I am apt to think, that this ſort of Light Land, acquires more Cement by having its *External* Superficies often changed, and expoſed to the Dews, and other Benefits of the Atmoſphere, as well as by the Increaſe of (its *Internal* Superficies, which is the Surfaces of all the Divided Parts of Earth or) the Paſture of Plants; the one being augmented by the other; *i.e.* That into the more Parts the Earth is broken, the more Cement will it attain, from the Sulphur, which is brought by the Dews.

Terra Damnata) is carried away, yet the Salts of this ſpread upon that barren part of the Staple, which is unburnt, divide it into ſo very minute particles, that their paſture will nouriſh Two or Three good Crops of Corn: But then the Plow, even with a conſiderable Quantity of Dung, is never able afterwards to make a Diviſion equal to what thoſe Salts have done, and therefore ſuch burnt Land remains barren.

Artificial Pores cannot be too ſmall; becauſe Roots may the more eaſily enter the Soil that has them, quite contrary to natural pores; for theſe may be, and generally are, too ſmall, and too hard, for the entrance of all weak Roots, and for the free entrance of ſtrong Roots.

Inſufficient Tillage leaves ſtrong Land with its natural Pores too ſmall, and its artificial Ones too large. It leaves light Land, with its natural and artificial Pores both too large.

Pores that are too ſmall in hard Ground, will not eaſily permit Roots to enter them.

Pores that are too large in Any ſort of Land, can be of little other uſe to Roots, but only to give them paſſage to other Cavities, more proper for them, and if in any place they lie open to the Air, they are dry'd up and ſpoil'd, before they reach them.

For fibrous Roots (which alone maintain the Plant, the other Roots ſerve for receiving the Chyle from them, and convey it to the Stem) can take in no Nouriſhment from any Cavity, unleſs they come into Contact with, and preſs againſt all the Superficies of that Cavity which includes them; for it diſpenſes the Food to their Lacteals, by ſuch preſſure only. But a fibrous Root is not ſo preſs'd by the Superficies of a Cavity, whoſe Diameter is greater than that of the Root.

The Surfaces of great Clods form Declivities on every ſide of them, and large Cavities; which are as Sinks to convey, what Rain and Dew bring, too quickly downwards to below the plow'd part.

The firſt and ſecond plowings, with common plows, ſcarce deſerve the Name of Tillage, they rather ſerve to prepare the Land for Tillage.

The Third, Fourth, and every ſubſequent plowing, may be of more Benefit and leſs Expence, than any of the preceding ones.

But the laſt plowings will be more advantageouſly perform'd by way of Hoeing, as in the following Chapters will appear.

For the finer Land is made by Tillage, the richer will it become, and the more plants it will maintain.

It has been often obſerv'd, that when part of a Ground has been better Till'd than the reſt, and the whole Ground conſtantly manag'd alike, afterwards for Six or Seven Years ſucceſſively, this part that was but once better Till'd, always produc'd a better Crop than the reſt, and the difference remained very viſible every Harveſt.

One part being once made finer, the Dews did more enrich it; for they penetrate within, and beyond the Superficies, whereto the Roots are able to enter; The fine parts of the Earth are Impregnate throughout their whole Subſtance, with ſome of the Riches carried in by the Dews, and there repoſited; until, by new Tillage, the Inſides of thoſe fine parts become Superficies; and as the Corn drains them, they are again ſupply'd as before: But the rough large parts cannot have that Benefit, the Dews not penetrating to their Centers, they remain poorer. *Minus habentibus minus datur, & vice verſa.*

I think nothing can be ſaid more ſtrongly, to confirm the Truth of this, than what is related by the Au-

Authors, quoted by Mr. *Evelyn*, (1) To this Effect, *viz.*

'Take of the moſt barren Earth you can find, 'pulverize it well, and expoſe it abroad for a Year 'inceſſantly agitated (2), it will become ſo fertile, 'as to receive an Exotic Plant, from the furtheſt 'Indies; and to cauſe all Vegetables to proſper in 'the moſt exalted degree, and to bear their Fruit 'as kindly with us, as in their natural Climates.

This artificial Duſt (3), He ſays, will entertain Plants which refuſe Dung, and other violent Applications, and that it has a more nutritive power than any Artificial Dungs, or Compoſt whatſoever: And further, that by this Toil of pulverizing "'tis found, "that Soil may be ſo ſtrangely alter'd from its for"mer Nature, as to render the harſh and moſt un"civil Clay (4), obſequious to the Husbandman, "and to bring forth Roots and Plants, which other"wiſe require the lighteſt and holloweſt Mould (5).

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(1) In Pag. 17, 18, and 19, of his *Phil. Diſcourſe of Earth.*

(2) *I. e.* Stirr'd often.

(3) Tho' it may be Impoſſible for the Plow to reduce the whole Staple into ſo fine Powder, yet the more Internal Superficies it makes, the more Duſt will be made by the Atmoſphere in Proportion; and great Clods perhaps are of no uſe to Plants, but by that Duſt they let fall, being thence extricated by the Inſenſible ferment of the Nitrous Air; and the Surfaces of this artificial Duſt muſt receive ſuch Operations from the Air, before the utmoſt Fertility be obtain'd.

(4) But I take harſh uncivil Clay to be the leaſt Profitable of any to keep in Tillage.

(5) To this Duſt, *Namque hoc imitamur arando*, ought to be apply'd, and not to *Putre ſolum*, which itſelf needs Tillage, as well as ſtrong Land; But it ſeems the Ancients did not obſerve the Difference between natural Pores (or Hollowneſs) and artificial ones, tho' it is very great, as is ſhewn in Chap. of *Paſture* of *Plants*, 'tis eaſier indeed to imitate this Artificial Duſt in *hollow*, than in *ſtrong* Land.

'Tis to be ſuppos'd, that the Indian Plants had their due Degrees of Heat and Moiſture given them, and I ſhould not chuſe to beſtow this Toil upon the pooreſt of Earth, in a Field or Garden, tho' that be the moſt ſure, wherein to make the Experiment.

I never myſelf try'd this way of Pounding or Grinding , becauſe Impracticable in the Fields.

But I have had the Experience of a Multitude of Inſtances, which confirm it ſo far, that I am in no doubt, that any Soil (1), (be it Rich or Poor) can ever be made too fine by Tillage.

For 'tis without diſpute, that one Cubical Foot of this minute Powder, may have more Internal Superficies, than a ThouſandCubical Foot of the ſame, or any other Earth Till'd in the common manner ; and, I believe, no Two arable Earths in the World, do exceed one another in their natural Richneſs Twenty Times ; That is, One Cubical Foot of the Richeſt, is not able to produce an equal Quantity of Vegetables, *cæteris paribus*, to Twenty Cubical Foot of the Pooreſt ; therefore 'tis not ſtrange, that the pooreſt, when by pulverizing it, has obtain'd one Hundred times the Internal Superficies of the Rich untill'd Land, it ſhould exceed it in Fertility. Or, if a Foot of the pooreſt was made to have Twenty times the Superficies of a Foot of ſuch rich Land, the pooreſt might produce an equal

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(1) Land that is too Hollow and Light having no Cement to join its parts together, tho' in Nature they are capable of Infinite Diviſion, yet in Practice, the Plow, cannot divide them to any purpoſe, unleſs they were firſt joyn'd, but glides thro' without breaking them; being more like to the primary Particles of Water againſt the Plow, which are broken by no force, than to Earth; it may be moved, but not broken by Tillage, and therefore ought not to be reputed Arable ; nor does it indeed deſerve the Name of Land, but as the deſart Sands of *Lybia*, to diſtinguiſh it from Sea.

Quantity of Vegetables with the rich(1). Beſides there is another extraordinary Advantage, when a Soil has a large Internal Superficies in a very little Compaſs; for then the Roots of Plants in it are better ſupply'd with Nouriſhment, being nearer to them on all ſides within reach, than it can be when the Soil is leſs fine, as in common Tillage; and the Roots in the one muſt extend much further than in the other, to reach an equal Quantity of Nouriſhment: They muſt range and fill perhaps above Twenty times more Space to collect the ſame quantity of Food.

But in this fine Soil, the moſt weak and tender Roots have free paſſage to the utmoſt of their extent, and have alſo an eaſy, due and equal Preſſure every where, as in Water.

Hard Ground makes a too great Reſiſtance, as Air makes a too little Reſiſtance, to the Superficies of Roots.

Farmers, juſt when they have brought their Land into a Condition, fit to be further Till'd, to much greater Advantage, leave off, ſuppoſing the Soil to be Fine enough, when, with the help of Harrows, they can cover the Seed; and afterwards with a Roller they break the Clods; to the end, that if a Crop ſucceed, they may be able to mow it, without being hindred by thoſe Clods. By what I could ever find, this Inſtrument, called a Roller, is ſeldom Beneficial to good Husbands: It rather Untills the Land, and Anticipates the ſubſiding of the Ground, which in ſtrong Land happens too ſoon of it ſelf (2).

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(1) And very poor Land, well pulveriz'd, will produce better Corn than very rich will do, without Manure or Tillage. The Experiment may be made by paring off the Turf, and ſetting Corn in the whole Ground that is very Rich; and that will ſhew how much the Natural Paſture of the Rich is Inferior to the Artificial Paſture of the Poor Land.

(2) This Injury the Roller does, is only when 'tis uſed to preſs

But more to blame are they, who neglect to give their Land due Plowing, truſting to the Harrow to make it fine; and when they have thrown in their Seed, go over it Twenty Times with the Harrows (1), till the Horſes have trodden it almoſt as hard as a High-way, which in moiſt Weather ſpoils the Crop: But on the Contrary, the very Horſes, when the Earth is moiſt, ought all to tread in the Furrows only, as in plowing with a Hoe-plow they always do, when they uſe it inſtead of a common Plow.

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preſs down the Earth, after the Seed is ſown; and is the greater if Land be moiſt; but the Rolling of it in dry Weather, when 'tis to be immediately plow'd up again, is the moſt ſpeedy Way to Pulverize the Soil, and the Harrow is then very uſeful in pulling up the Clods, to the end that the Roller may the better come at them to Cruſh them.

(2) *Nam veteres Romani dixerunt male ſubactum Agrum qui ſatis frugibus Occandus ſit.*

Sed ut compluribus iterationibus ſic reſolvatur Vervactum in pulverem, ut nullam vel exiguam deſideret occationem cum ſeminaverimus. Col. Lib. 2. Cap. 4.

Chap. VII. *Of HOEING.*

H*OEING* is the breaking or dividing the Soil by Tillage, whilſt the Corn or other Plants are growing thereon.

It differs from common Tillage (which is always perform'd before the Corn or Plants are ſown or planted) in the times of performing it; 'tis much more beneficial, and 'tis perform'd by different Inſtruments.

Land that is before ſowing Tilled never ſo much, (tho' the more 'tis Till'd the more it will produce) will have ſome Weeds, and they will come in along with the Crop for a ſhare of the Benefit of the

Tillage, greater or leſs, according to their Number, and what Species they are of.

But what is moſt to be regarded is, That as ſoon as the Plowman has done his Work of Plowing and Harrowing, the Soil begins to undo it, inclining towards, and endeavouring to regain its natural ſpecifick Gravity; the broken parts by little and little coaleſce, unite, and loſe ſome of their Surfaces, many of the Pores or Interſtices cloſe up during the Seed's Incubation, and hatching in the Ground; and as the Plants grow up, they require an Increaſe of Food, proportionable to their increaſing Bulk; but on the contrary, inſtead thereof, that internal Superficies, which is their Artificial Paſture, gradually decreaſes.

The Earth is ſo unjuſt to Plants, her own Offſpring, as to ſhut up her Stores in proportion to their Wants; that is, to give them leſs Nouriſhment when they have need of more; therefore Man, for whoſe uſe they are chiefly deſign'd, ought to bring in his reaſonable Aid for their relief, and force open her Magazines with the Hoe, which will thence procure them at all times Proviſions in abundance, and alſo free them from Intruders; I mean, their ſpurious Kindred, the Weeds, that robb'd them of their too ſcanty Allowance.

There's no doubt, but that one Third part of the Nouriſhment raiſed by Dung and Tillage, given to Plants or Corn at many proper Seaſons, and apportion'd to the different times of their Exigencies, will be of more Benefit to a Crop, than the Whole apply'd as it commonly is, only at the time of Sowing. This old Method is almoſt as unreaſonable as if Treble the full Stock of Leaves, neceſſary to maintain Silk-Worms 'till they had finiſhed their Spinning, ſhould be given them before they are Hatched, and no more afterwards.

Nature, by what ſhe does in the animal Oeconomy, ſeems to point out to us ſomething like Hoeing; for when Teeth as Plows have Till'd that Soil, or Maſs, (which is Earth alter'd) and when the Saliva and Ferment of the Stomach have ſerved for Stercoration to it; then as a thing of greateſt Benefit, the Bile and Pancreas are employed to further, divide and open, and as it were to Hoe it, at the very time when 'tis ready to be exhauſted by the greateſt Numbers of lacteal Mouths ſituate in the Inteſtines.

A Plant is almoſt as imperfectly nouriſhed by Tillage without Hoeing, as an animal Body would be without Gall and Pancreatick Juice. For Roots paſs along the Soil, as the Soil or Maſs paſſes along the Guts.

Next to Hoeing, and ſomething like it, is Tranſplanting, but much inferiour; both becauſe it requires a ſo much greater Number of Hands, that by no contrivance can it ever become general, nor does it ſucceed if often repeated; but Hoeing will maintain any Plant in the greateſt Vigour 'tis capable of, even unto the utmoſt Period of its Age. Beſides there is danger in removing a whole Plant, and loſs of Time before the Plant can take Root again, all the former Roots being broken off at the Ends in taking up (for 'tis impoſſible to do it without) and ſo muſt wait until by the Strength and Virtue of its own Sap (which by a continual Perſpiration is daily enfeebled) new Roots are form'd, which unleſs the Earth continue moiſt, are ſo long in forming, that they not only find a more difficult Reception into the cloſing Pores, but many times the Plant languiſhes and dies of an Atrophy, being ſtarv'd in the midſt of Plenty; but whilſt this is thus decaying, the Hoed Plant obtains a more flouriſhing State than ever, without removing from the ſame Soil that produc'd it.

'Tis obſerv'd that ſome Plants are the worſe for Tranſplanting (1). *Fennochio* remov'd is never ſo good and tender as that which is not; it receives ſuch a Check in Tranſplanting in its Infancy, which, like the Rickets, leaves Knots that indurate the parts of the *Fennel*, and ſpoil it from being a Dainty.

Hoeing, has moſt of the Benefits without any Inconveniencies of Tranſplanting; becauſe it removes the Roots by little and little, and at different times; ſome of the Roots remaining undiſturb'd, always ſupply the moved Roots with Moiſture, and the whole Plant with Nouriſhment ſufficient to keep it from fainting, until the moved Roots can enjoy the Benefit of their new Paſture, which is very ſoon.

Another extraordinary Benefit of the *New* Hoeing (2) Husbandry is, that it keeps Plants moiſt in dry Weather, and this upon a double Account.

Firſt, As they are better Nouriſh'd by Hoeing, they require leſs Moiſture, as appears by Dr. *Woodward*'s Experiment, that thoſe Plants which receive the greateſt Increaſe, having moſt Terreſtrial Nouriſhment, carry off the leaſt Water in proportion to their Augment; ſo Barley or Oats, being ſown on a part of a Ground very well divided by Dung and Tillage, will come up and grow vigorouſly without Rain, when the ſame Grains, ſown at the ſame time, on the other part, not thus enriched, will ſcarce come up, or if they do, will not thrive 'till Rain comes.

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(1) As moſt long Tap-Rooted Plants are; for I have often try'd the Tranſplanting of Plants, of *St. Foin* and *Luſerne*, and could never find, that any ever came near to the Perfection that thoſe will do which are not removed, being equally ſingle.

Tap-Rooted Graſſes and Turneps, are always injur'd by Tranſplanting; their long Root once broken off never arrives at the Depth it would have arriv'd unbroken; as for this reaſon they Cut off the Tap-Root of an Apple tree, to prevent its running downward, by which it would have too much Moiſture.

(2) Hoeing may be divided into Deep, (which is our Horſe-Hoeing) and Shallow, which is the *Engliſh* Hand-Hoeing; and alſo the Shallow Horſe-Hoeing, uſed in ſome Places betwixt Rows, where the Intervals are very narrow, as Sixteen or Eighteen Inches; this is but an Imitation of the Hand-Hoe, or a *Succedaneum* to it, and can neither ſupply the Uſe of Dung, nor of Fallow, and may be properly called Scratch-Hoeing.

Secondly, The Hoe, I mean the Horſe-Hoe (the other goes not Deep enough) procures Moiſture to the Roots from the Dews, which fall moſt in dry Weather; and thoſe Dews (by what Mr. *Thomas Henſhaw* has obſerv'd) ſeem to be the richeſt Preſent the Atmoſphere gives to the Earth; ' Having, ' when putrify'd in a Veſſel, a black Sediment like ' Mud at the Bottom. This ſeems to cauſe the darkiſh Colour to the upper part of the Ground: And the Sulphur, which is found in the Sediment of the Dew, may be the chief Ingredient of the Cement of the Earth; Sulphur being very glutinous, as Nitre is diſſolvent; Dew has both theſe.

Theſe enter in proportion to the fineneſs and freſhneſs of the Soil, and to the Quantity that is ſo made fine and freſh by the Hoe. How this comes to paſs, and the Reaſon of it, is ſhewn in the Chapter of *Tillage*.

To demonſtrate that Dews moiſten the Land when fine, dig a Hole in the hard dry Ground, in the drieſt Weather, as Deep as the Plow ought to reach: Beat the Earth very fine, and fill the Hole therewith; and, after a few Nights Dews, you'll find this fine Earth become moiſt at the Bottom, and the hard Ground all round will continue dry.

Till a Field in Lands, make one Land very Fine, by frequent deep plowings, and let another be Rough, by inſufficient Tillage alternately; then plow the whole Field croſs-ways in the drieſt Weather, which has continued long, and you will perceive, by the Colour of the Earth, that every Fine Land will be turn'd up Moiſt; but every Rough Land will be Dry as Powder, from Top to Bottom (1).

Altho' hard Ground, when thoroughly ſoak'd with Rain, will continue Wet longer than fine till'd Land adjoining to it; yet this Water ſerves rather to chill than nouriſh the Plants ſtanding therein, and to keep out the other Benefits of the Atmoſphere, leaving the Ground ſtill harder when 'tis thence exhaled; and being at laſt once become Dry, it can admit no more Moiſture, unleſs from a long continued Deluge of Rain (which ſeldom falls till Winter) which is not the Seaſon for Vegetation.

As fine Hoed Ground is not ſo long ſoaked by Rain, ſo the Dews never ſuffer it to become perfectly Dry; this appears by the Plants, which flouriſh and grow Fat in this, whilſt thoſe in the hard Ground are Starved, Except ſuch of them, which ſtand near enough to the Hoed (2) Earth, for the Roots to borrow Moiſture and Nouriſhment from it.

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(1) Theſe Experiments will ſhew, how it is in our own Power to make *Solſtitia* become in ſome meaſure *Humida*, inſtead of wiſhing them ſo; And alſo proves, The *Virgilian* Theory in this Verſe, *viz. Hic Sterilem exiguus ne deſerat Humor Arenam*, to be (as almoſt all the firſt *Georgic* is) directly Contrary to Truth

(2) As when Wheat is Drill'd late in very poor Land, ſo that in the Spring the young Plants look all very Yellow; let your Hoe Plow, making a crooked Line, like an Indention on one ſide of a ſtreight Row of this poor Wheat in the Spring, turn a Furrow from it, and in a ſhort time you will ſee all thoſe Yellow Plants, that are contiguous to this Furrow, Change their yellow Colour to a deep Green; whilſt thoſe Plants of the ſame Row, which ſtand fartheſt off from this Indented Furrow, change not their Colour till afterwards; and all the Plants change or retain their Colour ſooner or later gradually, as they ſtand

And I have been informed by ſome Perſons, that they have often made the like Obſervations; that in the drieſt of Weather, good Hoeing (1) procures Moiſture to Roots; tho' the Ignorant, and Incurious Fancy, it lets in the Drought, and therefore are afraid to Hoe their Plants at ſuch times, when, unleſs they Water them, they are ſpoil'd for want of it.

There is yet One more Benefit Hoeing gives to Plants, which by no Art can poſſibly be given to Animals: For all that can be done in feeding an Animal is, what has been here already ſaid of Hoeing; that is, to give it ſufficient Food, Meat and Drink, at the times it has occaſion for them; if you give an Animal any more, 'tis to no manner of purpoſe, unleſs you could give it more Mouths, which is impoſſible; but in Hoeing a Plant, the additional Nouriſhment thereby given, enables it to ſend out innumerable additional Fibres and Roots, as in the Glaſs with a *Mint* in it, mark'd *F*, is ſeen; which fully demonſtrates, that a Plant increaſeth its Mouths,

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ſtand nearer to, or farther from it; and the other Rows, which have no Furrow near them, continue their Yellow, after all this Row is become Green and flouriſhing: But this Experiment is beſt to be made in poor Sandy Ground, where the Mould is Friable, elſe perhaps the different Colour may not appear until the Furrow be turn'd back to the Row, having lain ſometime to be ſomewhat pulveriz'd, (or impregnated by the Weather, &c.

I never remember to have ſeen a Plant poor, that was contiguous to a Well-Hoed Interval, unleſs overpower'd by a too great Multitude of other Plants; and the ſame Exception muſt be made, if it were a Plant that required more or leſs Heat or Moiſture than the Soil, or Climate afforded.

(1) But to Hoe with advantage againſt dry Weather, the Ground muſt have been well Tilled or Hoed before; that the Hoe may go deep, elſe the Dews, that fall in the Night, will be exhaled back in the Heat of the Day.

in ſome proportion to the Increaſe of Food given to it: So that Hoeing, by the new Paſture it raiſes, furniſhes both Food and Mouths to Plants; and 'tis for want of Hoeing, that ſo few are brought to their full Growth and Perfection (1).

In what manner the Sarrition of the Antients was performed in their Corn, is not very clear; this ſeems to have been their Method, *viz.* When the Plants were ſometime come up, they harrowed the Ground, and pull'd out the Weeds by Hand; the Proceſs of this appears in *Columella*, where he directs the planting of *Medica* to be, but a ſort of Harrowing or Raking amongſt the young Plants, that the Weeds might come out the more eaſily: *Ligneis Raſtris ſtatim jacta ſemina obruantur. Poſt ſationem ligneis Raſtris ſarriendus & identidem runcandus eſt Ager, ne alterius generis herba invalidam Medicam perimat.*

They Harrowed and Hoed *Raſtris*; ſo that their *Occatio* and *Sarritio* were performed with much the ſame ſort of Inſtrument, and differed chiefly in the

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(1) A Ground was Drill'd with Ray-graſs and Barley, in Rows at Five Inches diſtance from each other; it produced a pretty good Crop of Ray-graſs the ſecond Year, as is uſual; there was adjoining to it a Ground of Turneps, that were in Rows, with wide Intervals Horſe-Hoed; they ſtood for Seed; and amongſt them there was in room of a Turnep, a ſingle Plant of Ray-graſs, which being Hoed as the Turneps were, had (in every one's Opinion that ſaw it) acquired a Bulk at leaſt equal to a Thouſand Plants of the ſame Species in the other Ground; tho' that vaſt Plant had no other advantage above the other, except its Singleneſs, and the Deep Hoeing.

I have ſeen a Chickweed, by the ſame means, as much encreas'd beyond its common Size; and a Plant of Muſtard-Seed, whoſe Collateral Branches, were much bigger than ever I ſaw a whole Plant of that ſort; it was higher than I could reach its Top, and indeed more like a Tree than an Herb; many other ſorts of Plants have I ſeen thus encreas'd beyond what I had ever obſerv'd before, but none ſo much as thoſe.

Time; the firſt was at Seed-time, to cover the Seed, or level the Ground; the other was to move the Ground after the Plants were up.

One ſort of their *Sarrition* was, *Segetes permota terra debere adobrui, ut fruticare poſſint.* Another ſort was thus: *In locis autem frigidis ſarriri nec adobrui, ſed plana Sarritione terram permoveri.*

For the better underſtanding of theſe two ſorts of Sarrition we muſt conſider, that the Antients ſowed their Corn under Furrow; that is, when they had harrowed the Ground, to break the Clods, and make it level, they ſowed the Seed, and then plowed it in; this left the Ground very uneven, and the Corn came up (as we ſee it does here in the ſame caſe) moſtly in the loweſt places betwixt the Furrows, which always lay higher; this appears by *Virgil's Cum Sulcos æquant Sata*: Now when they uſed *Plana Sarritio*, they harrowed Lengthways of the Furrows, which being ſomewhat harden'd, there could be little Earth thrown down thence upon the young Corn.

But the other ſort of Sarrition, whereby the Corn is ſaid *Adobrui*, to be cover'd; ſeems to be perform'd by Harrowing croſs the Furrows, which muſt needs throw down much Earth from the Furrows which neceſſarily fell upon the Corn.

How this did contribute to make the Corn *fruticare*, is another Queſtion: I am in no doubt to ſay, it was not from covering any part of it (for I ſee that has a contrary Effect) but from moving much Ground, which gave a new Paſture to the Roots; this appears by the Obſervation of the extraordinary Frutication of Wheat Hoed without being cover'd; and by the Injury it receives by not being uncover'd when any Earth falls on the Rows.

The ſame *Columella* ſaith, *Faba & cætera Legumina cum quatuor Digitis a terra extiterint recte ſarrientur*,

tur, excepto tamen Lupino, cujus Semini contraria eſt Sarritio; quoniam unam Radicem habet, quæ ſive Ferro ſucciſa ſeu vulnerata eſt, totus Frutex emoritur.

If they had Hoed it only betwixt Rows, there had been no danger of killing the *Lupine*, which is a Plant moſt proper for Hoeing; what he ſays of the *Lupines* having no need of Sarrition, becauſe it is able of it ſelf to kill Weeds, ſhews the Antients were ignorant of the chief Uſe of Hoeing, *viz.* to raiſe new Nouriſhment by dividing the Earth, and making a new internal Superficies in it.

Sarrition ſcratched and broke ſo ſmall a part of the Earth's Surface, amongſt the Corn and Weeds without diſtinction, or favouring one any more than the other, that it was a Diſpute, whether the Good it did, in facilitating the Runcation (or Hand-weeding) was greater, than the Injury it did by bruiſing and tearing the Corn: And many of the Antients choſe rather to content themſelves with the Uſe of Runcation only, and totally to omit all Sarrition of their Corn.

But Hoeing is an Action very different from that of Sarrition, and is every way beneficial, no way injurious to Corn, tho' deſtructive to Weeds; therefore ſome modern Authors ſhew a profound Ignorance, in miſtaking in tranſlating Sarritio for Hoeing; they give an Idea very different from the true one: For the Antients truly Hoed their Vineyards, but not their Corn; neither did they plant their Corn in Rows, without which they could not give it the Vineyard-Hoeing: Their Sarculation was uſed but amongſt ſmall Quantities of ſown Corn, and is yet in Uſe for Flax; for I have ſeen the Sarculum (which is a ſort of a very narrow Hoe) uſed amongſt the Plants of Flax ſtanding irregularly, but this Operation is too tedious and too chargeable, to be apply'd to great Quantities of irregular.

If they Hoed their Crops ſown at random, one would think they ſhould have made mad Work of it; ſince they were not at the pains to plant in Rows, and hoe betwixt them with their Bidens; being the Inſtrument with which they tilled many of their Vineyards, and enters as deep as the Plow, and is much better than the *Engliſh* Hoe, which indeed ſeems, at the firſt Invention of it, to be deſigned rather to ſcrape Chimneys, than to Till the Ground,

The higheſt and loweſt Vineyards are Hoed by the Plow, firſt the high Vineyards, where the Vines grow (almoſt like Ivy) upon great Trees, ſuch as Elms, Maples, Cherry-trees, *&c.* theſe are conſtantly kept in Tillage, and produce good Crops of Corn, beſides what the Trees do yield; and alſo theſe great and conſtant Products of the Vines, are owing to this ſort of Hoe-Tillage; becauſe neither in Meadow or Paſture Grounds can Vines be made to proſper; tho' the Land be much richer, and yet have a leſs quantity of Graſs taken off it, than the Arable has Corn carried from that.

The Vines of low Vineyards, Hoed by the Plow, have their Heads juſt above the Ground, ſtanding all in a moſt regular Order, and are conſtantly plowed in the proper Seaſon: Theſe have no other Aſſiſtance, but by Hoeing; becauſe their Heads and Roots are ſo near together, that Dung would ſpoil the Taſte of the Wine they produce, in hot Countries.

All Vineyards muſt be Hoed one way or other (1), or elſe they will produce nothing of Value; but Corn-fields without Hoeing do produce ſomething, tho' nothing in compariſon to what they would do with it.

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(1) Vines, that cannot be Hoed by the Plow, are Hoed by the Bidens.

Mr. *Evelyn* ſays, that when the Soil, wherein Fruit-trees are planted, is conſtantly kept in Tillage, they grow up to be an Orchard in half the Time, they would do, if the Soil were not Till'd; and this keeping an Orchard-Soil in Arable, is Horſe-hoeing it.

In ſome Places in *Berkſhire* they have uſed, for a long Time, to Hand-hoe moſt ſorts of Corn, with very great Succeſs; and I may ſay this, that I my ſelf never knew, or heard, that ever any Crop of Corn was properly ſo Hoed, but what very well anſwer'd the Expence, even of this Hand-work; but be this never ſo Profitable, there are not a Number of Hands to uſe it in great Quantities; which poſſibly was one Reaſon the Ancients were not able to introduce it into their Corn-fields to any Purpoſe; though they ſhould not have been ignorant of the Effect of it, from what they ſaw it do in their Vineyards and Gardens.

In the next Place I ſhall give ſome general Directions, which by Experience I have found neceſſary to be known, in order to the Practice of this Hoeing-Husbandry.

I. *Concerning the Depth to Plant at.*
II. *The Quantity of Seed to Plant:*
III. *And the Diſtance of Rows.*

I. 'Tis neceſſary to know how deep we may plant our Seed, without danger of Burying it; for ſo 'tis ſaid to be, when laid at a Depth below what 'tis able to come up at.

Different Sorts of Seeds come up at different Depths; ſome at Six Inches, or more; ſome at not more than Half an Inch: The way to know for certain the Depth any ſort will come up at is, to make Gages in this manner: Saw off 12 Sticks of about 3 Inches Diameter; bore a Hole in the End of each Stick, and drive into it a taper Peg, let the firſt Peg be Half an Inch long, the next an Inch, and ſo on; every Peg to be Half an Inch longer than the former, till the laſt Peg be Six Inches long; then in that ſort of Ground, where you intend to plant, make a Row of Twenty Holes with the Half-Inch Gage; put therein Twenty good Seeds; cover them up, and then ſtick the Gage at the End of that Row, then do the like with all the other Eleven Gages; this will determine the Depth, at which the moſt Seeds will come up.

When the Depth is known, wherein the Seed is ſure to come up, we may eaſily diſcover whether the Seed be good or not, by obſerving how many will fail: For in ſome Sorts of Seeds, the Goodneſs cannot be known by the Eye; and there has been often great Loſs by bad Seed, as well as by Burying good Seed; both which Misfortunes might be prevented by this little Trouble; beſides 'tis not convenient to plant ſome Sorts of Seed at the utmoſt Depth they will come up at; for it may be ſo Deep, as that the Wet may Rot or Chill the firſt Root, as in Wheat in moiſt Land.

The Nature of the Land, the Manner how it is laid, either Flat or in Ridges; and the Seaſon of Planting, with the Experience of the Planter, acquired by ſuch Trials, muſt determine the proper Depths for different Sorts of Seeds.

II. The proper *Quantity* of Seed to be Drill'd on an Acre, is much leſs than muſt be ſown in the common way, not becauſe Hoeing will not maintain as many Plants as the other; for on the contrary, Experience ſhews it will always, *cæteris paribus*, maintain more; but the Difference is upon many other Accounts: As that 'tis impoſſible to ſow it ſo even by Hand, as the Drill will do; for let the Hand ſpread it never ſo exactly (which is difficult to do ſome Seeds, eſpecially in windy Weather) yet the Unevenneſs of the Ground will alter the Situation of the Seed; the greateſt part rebounding into the Holes, and loweſt Places, or elſe the Harrows in Covering, draw it down thither; and tho' theſe low Places may have Ten times too much, the high Places may have little or none of it; this Inequality leſſens in effect the Quantity of the Seed; becauſe Fifty Seeds in room of One, will not produce ſo much as One will do, and where they are too thick, they cannot be well nouriſhed, their Roots not ſpreading too near their natural Extent, for want of Hoing to open the Earth. Some Seed is buried, (by which is meant the laying them ſo deep, that they are never able to come up, as *Columella* cautions, *Ut abſque ulla reſurrectionis ſpe ſepeliantur*) Some lies naked above the Ground; which, with more uncovered by the firſt Rain, feeds the Birds and Vermin.

Farmers know not the Depth that is enough to bury their Seed, neither do they make much Difference in the Quantity they ſow on a rough, or a fine Acre; tho' the ſame that is too little for the one, is too much for the other; 'tis all mere Chance-work, and they put their whole Truſt in good Ground, and much Dung, to cover their Errors.

The greateſt Quantity of Seed I ever heard of to be uſually ſown, is in *Wiltſhire*, where I am informed by the Owners themſelves, that on ſome ſorts of Land, they ſow Eight Buſhels of Barley to an Acre; ſo that if it produce Four Quarters to an Acre, there is but Four Grains for One that is ſown, and is a very poor Increaſe, tho' a good Crop; this is on Land plowed once, and then double Dung'd, the Seed only harrow'd into the ſtale and hard Ground, 'tis like not Two Buſhels of the Eight enters it to grow; and I have heard, that in a dry

Summer, an Acre of this ſcarce produces Four Buſhels at Harveſt.

But in Drilling, Seed lies all at the ſame juſt Depth, none Deeper, nor Shallower than the reſt; here is no danger of the Accidents of burying, or being uncover'd, and therefore no Allowance muſt be made for them; but Allowance muſt be made for other Accidents, where the ſort of Seed is liable to them, ſuch as Grub, Fly, Worm, Froſt, *&c.*

Next, when a Man unexperienc'd in this Method, has proved the Goodneſs of his Seed, and Depth to plant it at, he ought to calculate what Number of Seeds a Buſhel, or other Meaſure, or Weight contains: For one Buſhel, or one Pound of ſmall Seed, may contain double the Number of Seeds, of a Buſhel, or a Pound of large Seed of the ſame Species.

This Calculation is made by weighing an Ounce, and counting the Number of Seeds therein; then weighing a Buſhel of it, and multiplying the Number of Seeds of the Ounce, by the Number of Ounces of the Buſhel's Weight; the Product will ſhew the Number of Seeds of a Buſhel near enough: then by the Rule of Three, apportion them to the ſquare Feet of an Acre; or elſe it may be done, by dividing the Seeds of the Buſhel, by the ſquare Feet of an Acre; the Quotient will give the Number of Seeds for every Foot: alſo conſider how near you intend to plant the Rows, and whether Single, Double, Treble, or Quadruple; for the more Rows, the more Seed will be required (1).

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(1) The narrow Spaces (ſuppoſe Seven Inches) betwixt Double, Treble, or Quadruple Rows; the Double having One, the Treble Two, and the Quadruple Three of them, are called *Partitions.*

The wider Space (ſuppoſe of near Five Foot) betwixt any Two of theſe Double, Treble, or Quadruple Rows, is call'd an *Interval.*

Examine what is the Produce of one middle-ſiz'd Plant of the Annual, but the Produce of the beſt and largeſt of the perennial Sort; becauſe That by Hoeing will be brought to its utmoſt Perfection; Proportion the Seed of both to the reaſonable Product, and when 'tis worth while, adjuſt the Plants to their competent Number with the Hand-hoe, after they are up; and plant Perennials generally in ſingle Rows; laſtly, plant ſome Rows of the Annual thicker than others, which will ſoon give you Experience (better than any other Rule) to know the exact Quantity of Seed to Drill.

III. The *Diſtances* of the Rows is one of the moſt material Points, wherein we ſhall find many apparent Objections againſt the Truth; which, tho' full Experience be the moſt infallible Proof of it, yet the World is by falſe Notions ſo prejudiced againſt wide Spaces between Rows, that unleſs theſe common (and I wiſh I could ſay, only vulgar) Objections be firſt anſwered, perhaps No-body will venture ſo far out of the old Road, as is neceſſary to gain the Experience, without it be ſuch as have ſeen it.

I formerly was at much Pains and ſome Charge in Improving my Drills, for planting the Rows at very near Diſtances, and had brought them to ſuch Perfection, that One Horſe would draw a Drill with Eleven Shares, making the Rows at Three Inches and Half diſtance from one another; and at the ſame time Sow in them, Three very different Sorts of Seeds, which did not mix, and theſe too at different Depths; as the Barley Rows were Seven Inches aſunder, the Barley lay Four Inches deep; a little more than Three Inches above that, in the ſame Channels, was Clover; betwixt every Two of theſe Rows was a Row of St. Foin, cover'd half an Inch deep.

I had a good Crop of Barley the firſt Year; the next Year, Two Crops of Broad-Clover, where that was ſown; and where Hop-Clover was ſown, a mix'd Crop of That and St. Foin, and every Year afterwards a Crop of St. Foin; but I am ſince, by Experience, ſo fully convinced of the Folly of theſe, or any other ſuch mix'd Crops, and more eſpecially of Narrow Spaces; that I have demoliſh'd theſe Inſtruments (in their full Perfection) as a vain Curioſity, the Drift and Uſe of them being contrary to the true Principles and Practice of Horſe-Hoeing.

Altho' I am ſatisfied that every One, who ſhall have ſeen as much of it as I have, will be of my Mind in this Matter; yet I am aware, that what I am going to advance, will ſeem ſhocking to them, before they have made Trials.

I lay it down as a Rule (to my ſelf) That every Row of Vegetables, to be Horſe-hoed, ought to have an empty Space or Interval of Thirty Inches on one Side of it (1) at leaſt, and of near Five Foot in all Sorts of Corn.

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(1) *Note.* We call it one Row, tho' it be a Double, Treble, or Quadruple Row; becauſe when they Unite in the Spring, they ſeem to be all ſingle, even the Quadruple then is but as one ſingle Row.

Obſerve, that as wide Intervals are neceſſary for perfect Horſe-Hoeing, ſo the largeſt Vegetables have generally the greateſt Benefit by them; tho' ſmall Plants may have conſiderable Benefit from much narrower Intervals than Five Foot.

The Intervals may be ſomewhat narrower for conſtant annual Crops of Barley, than of Wheat; becauſe Barley does not ſhut out the Hoe-Plow, ſo ſoon, nor require ſo much Room for Hoeing, nor ſo much Earth in the Intervals, it being a leſſer Plant, and growing but about a Third part of the time on the Ground; but he that Drills Barley, muſt reſolve to Reap it, and bind it up in Sheaves; for if he Mows it, or does not bind it, a great part will be loſt among the Earth in the Intervals: Yet I think, that Six-Foot Ridges for Barley in Quadruple Rows, are more profitable; eſpecially on a Thin Soil.

In Hand-Hoeing there is always leſs Seed, fewer Plants, and a greater Crop, *cæteris paribus*, than in the common Sowing; yet there, the Rows muſt be much nearer together, than in Horſe-Hoeing; becauſe as the Hand moves many times leſs Earth than the Horſe, the Roots would be ſent out in like Proportion; and if the Spaces or Intervals, where the Hand-Hoe only ſcratches a little of the upper Surface of them, ſhould be wide, they would be ſo hard and ſtale underneath, that the Roots of perennial Plants, would be long in running thro' them; and the Roots of many annual Plants would never be able to do it.

An Inſtance which ſhews ſomething of the Difference between Hand-Hoeing and Deep-Hoeing is, That a certain Poor Man is obſerv'd to have his Cabbages vaſtly bigger than any body's elſe, tho' their Ground be richer, and better dung'd; his Neighbours were amaz'd at it, till the Secret at length came out, and was only this, as other People Hoe'd their Cabbages with a Hand-Hoe, he inſtead thereof dug his with a Spade: And nothing can more nearly equal (1) the Uſe of the Horſe-hoe than the Spade does.

And when Plants have never ſo much Pabulum near them, their fibrous Roots cannot reach it all, before the Earth naturally excludes them from it; for to reach it all, they muſt fill all the Pores (2), which is impoſſible: So far otherwiſe it is, that we ſhall find it probable, that they can only reach the leaſt part of it, unleſs the Roots could remove themſelves from Place to Place, to leave ſuch Pores as they had exhauſted, and apply themſelves to ſuch as were unexhauſted; but they not being endow'd with Parts neceſſary for local Motion (as Animals are) the Hoe-Plow ſupplies their want of Feet; and both conveys them to their Food, and their Food to them, as well as provides it for them; for, by Tranſplanting the Roots, it gives them Change of the Paſture, which it encreaſes by the very Act of Changing them from one Situation to another, if the Intervals be wide enough for this Hoeing Operation to be properly perform'd.

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(1) The Hoe-Plow exceeds the Spade in this reſpect that it removes more of the Roots, and cuts off fewer, which is an Advantage when we Till near to the Bodies of Plants that are grown large.

(2) The Roots of a *Mint*, ſet a whole Summer in a Glaſs, kept conſtantly repleniſhed with Water, will in Appearance, fill the whole Cavity of the Glaſs; but by compreſſing the Roots, or by obſerving how much Water the Glaſs will hold when the Roots are in it, we are convinc'd, that they do not fill a Fourth part of its Cavity; tho' they are not ſtopp'd by Water, as they are by Earth.

The Objections moſt likely to prepoſſeſs Peoples Minds, and prevent their making Trials of this Huſbandry, are theſe:

Firſt, They will be apt to think, that theſe wide, naked Spaces, not being *Cover'd* by the Plants, will not be ſufficient to make a good Crop.

For Anſwer, We muſt conſider, that tho' Corn ſtanding irregular and *ſparſim*, may ſeem to cover the Ground better than when it ſtands regular in Rows, this Appearance (1) is a mere *Deceptio viſus*; for Stalks are never ſo thick on any Part of the Ground, as where many come out of one Plant, or as when they ſtand in a Row; and a Hoed Plant of Corn will have Twenty or Thirty Stalks (2), in the ſame quantity of Ground where an Unho'd Plant, being equally ſingle, will have only Two or Three Stalks. Theſe Tillered Ho'd Stalks, if they were planted *ſparſim* all over the Interval, it might ſeem well cover'd, and perhaps thicker than the ſown Crop commonly is; ſo that tho' theſe Hoed Rows, ſeem to contain a leſs Crop, they may contain in reality a greater Crop than the ſown, that ſeems to exceed it; and 'tis only the different placing, that makes one ſeem greater, and the other leſs than it really is; and this is only when both Crops are Young.

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(1) For the Eye to make a Compariſon betwixt a ſown Crop, and ſuch a Hoed Crop, it ought when 'tis half grown to look on the Hoed Crop a-croſs the Rows, becauſe in the other it does ſo, in effect, which way ſoever it looks; but whatever Appearance the Hoed Crop of Vegetables (of as large a Species as Wheat) makes when Young, it ſurely, if well managed, appears more beautiful at Harveſt than a Sown Crop.

(2) I have counted Fifty large Ears on one ſingle Hoed Plant of Barley.

The next Objection is, That the Space or Interval not being *planted*, much of the Benefit of that Ground will be loſt; and therefore the Crop muſt be leſs than if it were planted all over.

I Anſwer, It might be ſo, if not Horſe-hoed; but if well Horſe-hoed, the Roots can run through the Intervals; and having more Nouriſhment, make a greater Crop.

The too great Number of Plants, plac'd all over the Ground in common ſowing, have whilſt it is open, an Opportunity of *waſting*, when they are very young, that Stock of Proviſion, for want of which, the greateſt Part of them are afterwards ſtarved; for their irregular ſtanding prevents their being relieved with freſh Supplies from the Hoe: Hence it is, that the old Method exhauſting the Earth to no purpoſe, produces a leſs Crop; and yet leaves leſs Pabulum behind for a ſucceeding one, contrary to the Hoeing-Husbandry, wherein Plants are manag'd in all reſpects by a quite different Oeconomy.

In a large Ground of Wheat it was prov'd, that the wideſt Hoed Intervals brought the greateſt Crop of all: Dung without Hoeing, did not equal Hoeing without Dung. And what was moſt remarkable, amongſt Twelve Differences of wider and narrower Spaces, more and leſs Hoed, dung'd and undung'd, the Hand-ſow'd was conſiderably the worſt of all; tho' all the Winter, and Beginning of the Spring, that made infinitely the moſt promiſing Appearance; but at Harveſt yielded but about one fifth part of Wheat of that which was moſt Hoed; there was ſome of the moſt Hoed, which yielded Eighteen Ounces of clean Wheat in a Yard in length of a Double Row, the Intervals being Thirty Inches, and the Partition Six Inches (1).

A Third Objection like the Two former is, That ſo ſmall a Part of the Ground, as that whereon the Row ſtands, cannot contain Plants or Stalks ſufficient for a full Crop.

This ſome Authors endeavour to ſupport by Arguments taken from the perpendicular Growth of Vegetables, and the room they require to ſtand on; both which I having anſwer'd elſewhere, I need not ſay much of them here; only I may add, that if Plants could be brought to as great Perfection, and ſo to ſtand as thick all over the Land, as they do in the Hoed Rows, there might be produc'd at once many of the greateſt Crops of Corn that ever grew.

But ſince Plants thrive, and make their Produce in Proportion to the Nouriſhment they have within the Ground, not to the Room they have to ſtand upon it, one very narrow Row may contain more Plants than a wide Interval can nouriſh, and bring to their full Perfection, by all the Art that can be uſed; and 'tis impoſſible a Crop ſhould be loſt for want of room to ſtand above the Ground, tho' it were leſs than a Tenth Part of the Surface (1).

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(1) The ſame Harveſt, a Yard in Length of a Double Row of Barley, having Six Inches Partition, produc'd Eight Hundred and Eighty Ears in a Garden; but the Grains happen'd to be eaten by the Poultry before 'twas ripe, ſo that their Produce of Grains could not be known: One like Yard of a Hoed Row of Wheat in an undung'd Field, produc'd Four Hundred Ears of Lammas Wheat.

'Tis no great Wonder, that Aſtronomers take Notice of thoſe Parts of Plants alone, which exiſt within that Element, where they are accuſtomed to make their Stellary Obſervations ; or treat of them only as they regard their Zenith, not enquiring what is done by the Roots, within the Earth's dark Receſſes, or how much of her Dimenſions is neceſſary to employ them in their Office.

But I ſhould have thought Mr. *Laurence* a better Philoſopher, than to be ſo much Impoſed on by that Quibling Fallacy of Mr. *Bradley*'s, about the Perpendicular Growth of Plants, as to call it a Demonſtration : " And as to Hills, tho' they meaſure near " Twice as much as the plain Ground they ſtand " upon, yet the Produce of the one can be no more

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(1) Mr. *Houghton* calculates, That a Crop of Wheat of Thirty Quarters to an Acre, each Ear has Two Inches and a Half of Surface ; by which 'tis evident, that there wou'd be Room for many ſuch prodigious Crops to ſtand on.

And a Quick-Hedge ſtanding between two Arable Grounds, one Foot Broad at Bottom, and Eighteen Foot in Length, will, at Fourteen Years Growth, produce more of the ſame ſort of Wood, than Eighteen Foot ſquare of a Coppice will produce in the ſame time, the Soil of both being of equal Goodneſs.

This ſeems to be the ſame Caſe with our Hoed Roes ; the Coppice if it were to be Cut in the firſt Years, would yield perhaps Ten times as much Wood, as the Hedge ; but many of the Shoots of the Coppice conſtantly die every Year, for want of ſufficient Nouriſhment, until the Coppice is fit to be cut ; and then its Product is much leſs than that of the Hedge, whoſe Paſture has not been overſtock'd to ſuch a Degree as the Coppice Paſture has been ; and therefore brings its Crop of Wood to greater Perfection than the Coppice-Wood, which has Eighteen times the Surface of Ground to ſtand on ; The Hedge has the Benefit of Hoeing, as oft as the Land on either ſide of it is Till'd ; but the Coppice, like the ſown Corn, wants that Benefit.

" than the Produce of the other: See Mr. *Laurence*'s *New Syſtem*, Page 63.

'Tis very likely, that Reverend Gentleman may have had Opportunities (unleſs he Preaches no better than he Plows) of ſeeing all his Pariſhioners ſtand Perpendicularly in his Church, as in a Row; but his Tythe might put him in Mind, that many Acres of Space, or Surface more than the Church's Area, are neceſſary for their Nouriſhment; without which, Hunger would ſoon bring them from their Perpendicular Poſture, to an Horizontal one; and he might perform his laſt Office for them all at once.

And juſt ſo it is with Plants, tho' theſe Gentlemen by their Arguments about them ſeem to think otherwiſe; elſe they would not attempt to Calculate the Quantity of the Earth's Surface neceſſary for them, by the manner of their Growth; it being nothing to the Purpoſe, whether it be Perpendicular or not: But 'tis true, that Perpendicular Plants have moſt Benefit by Hoeing; becauſe by that Poſture they admit the Hoe to come the oftner amongſt them.

In wide Intervals there is another Advantage of Hoeing, I mean Horſe-Hoeing; (the other being more like ſcratching and ſcraping than Hoeing) there is room for many Hoeings (1), which muſt not come very near the Bodies of ſome annual Plants, except whilſt they are young; but in narrow Intervals this cannot be avoided at every Hoeing: 'tis true, that in the laſt Hoeings, even in the Middle of a large Interval, many of the Roots may be broke off by the Hoe-Plow, at ſome conſiderable Diſtance from the Bodies; but yet this is no Damage, for they ſend out a greater Number of Roots than before; as in the *Mint*, mark'd *F*, in Chap. I. appears.

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(1) Many Hoeings; But if it ſhould be asked how many, we may take *Columella*'s Rule in Hoeing the Vines, *viz. Numerus autem vertendi Soli (bidentibus) definiendus non eſt, cum quanto crebrior ſit, plus prodeſſe foſſionem conveniat. Sed impenſarum ratio modum poſtulat.* Lib. 4. Cap. 5.

Neither is it altogether the Number of Hoeings that Determine the Degrees of Pulveration; For, Once well done, is Twice done, and the oftner the better; if the Expence be not exceſſive.

Poor Land, be it never ſo Light, ſhould have the moſt Hoeings; becauſe Plants receiving but very little Nouriſhment from the natural Paſture of ſuch Land, require the more Artificial Paſture to ſubſiſt on.

In wide Intervals, thoſe Roots are broken off only where they are ſmall, for tho' they are capable of running out to more than the length of the external parts of a Plant; yet 'tis not neceſſary they ſhould always do ſo; if they can haveſufficient Food nearer to the Bodies (1) of the Plants.

And theſe new, young, multiply'd Roots are fuller of Lacteal Mouths than the older ones, which makes it no wonder, that Plants ſhould thrive faſter by having ſome of their Roots broken off by the Hoe; for as Roots do not enter every Pore of the Earth; but miſs great part of the Paſture, which is left unexhauſted, ſo when new Roots ſtrike out from the broken parts of the old, they meet with that Paſture, which their Predeceſſors miſs'd, beſides that new Paſture which the Hoe raiſes for them; and thoſe Roots which the Hoe pulls out without breaking and covers again, are turn'd into a freſh Paſture; ſome broken and ſome unbroken, all together invigorate the Plants.

Beſides, the Plants of ſown Corn being Treble in Number, to thoſe of the Drill'd, and of equal Strength and Bulk, whilſt they are very young, muſt exhauſt the Earth whilſt it is open, Thrice as much as the Drill'd Plants do ; and before the ſown Plants grow large, the Pores of the Earth are ſhut againſt them, and againſt the Benefit of the Atmoſphere ; but for the Drill'd, the Hoe gives conſtant admiſſion to that Benefit ; and if the Hoe procures them (by dividing the Earth) Four times the Paſture of the ſown, during their Lives, and the Roots devour but one half of that, than tho' the Hoed Crop ſhould be double to the ſown, yet it might *leave* Twice as much Pabulum for a ſucceeding Crop. 'Tis impoſſible to bring theſe Calculations to Mathematical Rules, but this is certain in Practice, That a ſown Crop, ſucceeding a large Undung'd Hoed Crop, is much better than a ſown Crop, that ſucceeds a ſmall Dung'd ſown Crop. And I have the Experience of poor, worn out Heath-Ground, that having produc'd Four ſucceſſive good Hoed Crops of *Potatoes* (the laſt ſtill beſt) is become tolerable good Ground.

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(1) All the Mould is never ſo near to the Bodies of Plants, as 'tis when the Row ſtands on a high Six-foot Ridge, when the middle of the Interval is left bare of Earth, at the laſt Hoeing; for then all the Mould may be but about a Foot, or a Foot and half diſtant from the Body of each Plant of a Treble Row.

In a very poor Field were planted *Potatoes*, and in the very worſt part of it, ſeveral Lands had them in Squares a Yard aſunder ; theſe were plowed Four ways at different times ; ſome other Lands adjoining to them, of the very ſame Ground, were very well Dung'd and Till'd ; but the *Potatoes* came irregularly, in ſome places thicker, and in others thinner ; theſe were not Hoed, and yet at firſt coming up, looked blacker and ſtronger than thoſe in Squares not Dung'd, neither that Year, or ever, that I know of ; yet theſe Lands brought a good Crop of the largeſt Potatoes, and very few ſmall ones amongſt them ; but in the dung'd Lands, for want of Hoeing, the *Potatoes* were not worth the taking up, which proves, that in thoſe Plants that are planted ſo as to leave Spaces wide enough for Repetitions of Hoeing, that In-

Inſtrument can raiſe more Nouriſhment to them, than a good Coat of Dung with common Tillage.

Another thing I have more particularly obſerv'd, *viz.* That the more ſucceſſive Crops are planted in wide Intervals and often Hoed, the better the Ground does maintain them; the laſt Crop is ſtill the beſt, without Dung or changing the Sort of Plant; and this is ſo viſible, in parts of the ſame Field, where ſome part having a Firſt, ſome other part a Second, the reſt a Third Crop growing altogether at the ſame time; which ſeems to prove, that as the Earth is made by this Operation to diſpenſe, or diſtribute her Wealth to Plants, in proportion to the Increaſe of her Inner Superficies (which is the Paſture of Plants) ſo the Atmoſphere, by the riches in Rain and Dews, does annually reimburſe her in proportion to the ſame Superficies, with an Overplus for Intereſt: But if that Superficies be not increaſed to a competent Degree, and by frequent Repetitions of Hoeing, kept increaſing (which never happens in common Husbandry) this Advantage is loſt; and without often repeated Stercoration, every Year's Crop grows worſe; and it has been made evident by Trials, which admit of no diſpute, That Hoeing, without Dung or Fallow, can make ſuch Plants as ſtand in wide Intervals, more vigorous in the ſame Ground, than both common Dunging and Fallowing can do without Hoeing.

This ſort of Hoeing has in Truth every Year the Effect of a Summer-fallow; tho' it Yearly produce a good Crop.

This is one Reaſon of the different Effects, Plants have upon the Soil; ſome are ſaid to Enrich it, others to Burn it (*i. e.*) to impoveriſh it; But I think it may be obſerved, that all thoſe Plants, which are uſually Hoed, are reckoned among the Enrichers; and tho' it be certain, that ſome Species of

Plants are, by the Heat of their Conſtitution, greater Devourers than thoſe of another Species of equal Bulk; yet there is Reaſon to believe, that were the moſt Cormorant Plant of them all, to be commonly Hoed, it would gain the Reputation of an Enricher or Improver of the Soil; except it ſhould be ſuch, as might occaſion Trouble, by filling it full of its ſhatter'd Seeds, which might do the Injury of Weeds to the next Crop; and, except ſuch Plants, which have a vaſt Bulk to be maintained a long Time, as Turnep-ſeed (1).

The wider the Intervals are, the more Earth may be divided, for the Row takes up the ſame Room with a wide, or a narrow Interval; and therefore with the wide, the Unhoed part bears a leſs Proportion to be Hoed part than in the narrow.

And 'tis to no purpoſe to Hoe, where there is not Earth to be Hoed, or Room to Hoe it in.

There are many ways of Hoeing with the Hoe-Plow; but there is not Room to turn Two *deep*, *clean* Furrows in an Interval that is Narrower than Four Foot Eight Inches; for if it want much of this Breadth, One at leaſt, of theſe Furrows will reach, and fall upon the next Row, which will be very injurious to the Plants; except of grown *St. Foin*, and ſuch other Plants, that can bear to have the Earth pull'd off them by Harrows.

Thus much of Hoeing in general may ſuffice; and different ſorts of Plants requiring different Management; that may more properly be deſcribed in the Chapter where particular Vegetables are treated of.

It may not be amiſs to add, that all ſorts of Land are not equally proper for Hoeing; I take it, that a Dry Friable Soil is the beſt. Intractable wet Clays, and ſuch Hills that are too ſteep, for Cattle to Draw a Plow up and down them, are the moſt improper (1).

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(1) *Turneps* run to Seed, not till the ſecond Summer.

That 'tis not ſo Beneficial to Hoe in Common Fields, is not in reſpect of the Soil; but to the *Virgilian* Principles, which have bound the Owners to unreaſonable Cuſtoms of Changing the Species of Corn, and make it neceſſary to Fallow, every Second, Third or Fourth Year at fartheſt.

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(1) For by Hoeing croſs the Hill, the Furrow turn'd againſt the Declivity cannot be thrown up near enough to the Row above it; and the Furrow that is turn'd downwards will Bury the Row below it.

Chap. VIII. Of WEEDS.

PLANTS, that come up in any Land, of a different Kind from the ſown or planted Crop, are Weeds.

That there are in Nature any ſuch things as *inutiles Herbæ*, the Botaniſts deny; and juſtly too, according to their meaning.

But the Farmer, who expects to make Profit of his Land, from what he ſows or plants in it, finds not only *Herbæ inutiles*, but alſo *noxiæ*, unprofitable and hurtful Weeds; which come like *Muſcæ*, or uninvited Gueſts, that always hurt, and often ſpoil his Crop, by devouring what he has, by his Labour in Dunging and Tilling, provided for it's Suſtenance.

All Weeds as ſuch are pernicious, but ſome much more than others; ſome do more Injury, and are more eaſily deſtroyed; ſome do leſs Injury, and are harder to kill; others there are, which have both theſe bad Qualities. The hardeſt to kill are ſuch as will grow and propagate by their Seed, and alſo by every piece of their Roots, as Couch-Graſs, Coltsfoot, Melilot, Fern, and ſuch like. Some are hurtful only by robbing Legitimate (or Sown) Plants of their Nouriſhment, as all Weeds do; others both leſſen a Legitimate Crop by robbing it, and alſo ſpoil that Crop, which eſcapes their Rapine, when they infect it with their nauſeous Scent and Reliſh, as Melilot, Wild-Garlick, *&c.*

Weeds ſtarve the ſown Plants, by robbing them of their Proviſion of Food (1), not of their Room (as ſome Authors vainly imagine) which will appear by the following Experiment.

Let Three Beds of the ſame Soil, equal, and equally prepared, be ſown with the ſame ſort of Corn. Let the Firſt of theſe Beds be kept clean from Weeds: In the Second, Let a Quantity of Weeds grow along with the Corn; and in the Third, ſtick up a Quantity of dead Sticks, greater in Bulk than the Weeds.

It will be found, that the Produce of the Corn in the Firſt, will not exceed that of the Third Bed; but in the Second, where the Weeds are, the Corn will be diminiſh'd in Proportion to the Quantity of Weeds amongſt it.

The Sticks, having done no Injury to the Corn, ſhew there was Room enough in the Bed for Company to Lodge, would they forbear to Eat; or elſe (like Travellers in *Spain*) bring their Proviſion with them to their Inn, or (which would be the ſame thing) if Weeds could find there, ſome Diſh ſo diſagreeable to the Palate of the Corn, and agreeable to their own, that they might Feed on it without Robbing, and then they would be as Innocent as the Sticks, which take up the ſame Room with the Weeds.

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(1) A Tree of any Sort will ſpoil Corn all round it, in a large Circle; half an Acre of Turneps has been ſpoil'd by one: Hereby 'tis plain, That Trees rob as Weeds; becauſe 'tis not by their Shadow, there being as much Damage done by them on the South-ſide, where their Shadow never comes, as on their North-ſide; nor can it be by their Droping, for 'tis the ſame on the ſide where a Tree has no Boughs to drop over the Plants, when they are alſo at a very great diſtance from all Parts of the Tree, except its Roots.

The Quantity of Nouriſhment Weeds rob the Corn of, is not in proportion only to their Number and Bulk, but to the Degrees of Heat in their Conſtitution, as appears by the Inſtance of Charlock and Turneps, mention'd in the Chapter *Of Change of Species*.

'Tis needleſs to go about to compute the Value of the Damage Weeds do, ſince all Experienc'd Husbandmen know it to be very great, and would Unanimouſly agree to extirpate their whole Race as entirely, as in *England* they have done the Wolves, tho' much more Innocent, and leſs Rapacious than Weeds (1).

But alas! they find it Impoſſible to be done, or even to be hoped for, by the common Husbandry; and the Reaſons I take to be theſe:

The Seeds of moſt ſorts of Weeds are ſo hardy, as to lie ſound and uncorrupt for many Years (2), or perhaps Ages, in the Earth; and are not kill'd until they begin to grow or ſprout, which very few of them do, unleſs the Land be plow'd, and then enough of them will ripen amongſt the ſown Crop, to propagate and continue their Species, by ſhedding their Offspring in the Ground (for 'tis obſerv'd they are generally ripe before the Corn) and the Seeds of theſe do the ſame in the next ſown Crop; and thus perpetuate their ſavage, wicked (1) Brood, from Generation to Generation.

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(1) If we conſider the Crops they utterly deſtroy, and thoſe they extremely diminiſh; and that very few Crops eſcape without receiving Injury from them; it may be a Queſtion, Whether the Miſchief Weeds do to our Corn, is not as great as the Value of the Rent of all the Arable Lands in *England*.

(2) The Seeds of *Lethean Poppy* (call'd *Red-Weed*) has lain dormant 24 Years (the Land being, during that time, in *St. Foin*) and then at firſt plowing they came up very thick; this I have ſeen, and ſo will many other Sorts of Weeds, when the Ground has lain Untill'd, for an Age.

Beſides, their Seeds never all come up in one Year, unleſs the land be very often plow'd; for they muſt have their exact Depth, and Degrees of Moiſture and Heat to make them grow; and as ſuch as have not theſe, will lie in the Ground, and retain their vegetative Virtue for Ages; and the common uſual Plowings, not being ſufficient to make them all, or the greateſt part grow, almoſt every Crop that ripens increaſes the Stock of Seed, until it make a conſiderable part of the Staple of ſuch Land as is ſown without good Tillage and Fallowing.

The beſt Defence againſt theſe Enemies, which the Farmer has hitherto found, is to endeavour their Deſtruction, by a good Summer-Fallow; this indeed, if the Weather be propitious, does make Havock of them; but ſtill ſome will eſcape one Year's Proſecution.

Either by being ſometimes ſituate ſo high, that the Sun's Heat dries them, ſometimes lying ſo deep it cannot reach them; either way their Germination, which would have proved their Death, is prevented.

Another Faculty ſecures abundance of them, and that is, their being able to endure the Heat and Moiſture of one Year without growing; as Wild-Oats, and innumerable other ſorts of Weeds will do; for gather theſe when ripe, ſow them in the richeſt Bed, Water them, and do all that is poſſible to make them Grow the firſt Year, it will be vain Labour; they will reſiſt all Enticements 'till the ſecond; that is, if you gather them in Autumn, you cannot force them to grow until the next Spring come Twelve-month; and many of them will remain dormant even to the next Year after that, and ſome of them longer.

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(1) The *French* call them, *les Herbs Sauvages, & les mechantes Herbes.*

By this means, One Year's Summer-Fallow can have no Effect upon them, but to prepare the Soil for their more vigorous Growth, and plentiful Encreaſe the next Year after, and very rarely will the Farmer Fallow his Land two Years ſucceſſively: and often the Dung, which is made of the Straw of ſown Corn, being full of the Seeds of Weeds, when ſpread on the Fallows, encumbers the Soil with another Stock of Weeds, as ample as that, the Fallowing has deſtroy'd; and tho' perhaps many of theſe may not Grow the next Year, they will be ſure to come up afterwards.

The other old Remedy is what often proves worſe than the Diſeaſe; that is, what they call Weeding among ſown Corn; for if by the Hook or Hand they cut ſome Sorts (as Thiſtles), while they are young, they will ſprout up again, like *Hydras*, with more Heads than before; and if they are cut when full grown, after they have done almoſt their utmoſt in Robbing the Crop, 'tis like ſhutting the Stable-Door after the Steed is ſtol'n.

Hand-Weeders do often more Harm to the Corn with their Feet, than they do Good by Cutting or Pulling out the Weeds with their Hands; and yet I have known this Operation ſometimes coſt the Farmer Twelve Shillings an Acre; beſides the Damage done by treading down his Wheat; and after all, a ſufficient Quantity of them have eſcaped, to make a too plentiful Encreaſe in the next Crop of Corn.

The New Hoeing-Husbandry in time will probably make ſuch an utter Riddance (1) of all ſorts of Weeds, except ſuch as come in the Air (2), that as long as this Management is properly continued, there is no Danger to be apprehended from them; which is enough to confute the old Error of equivocal Generation, had it not been already ſufficiently exploded, ever ſince that Demonſtration of *Malpighius's* Experiment. For if Weeds were brought forth without their proper Seeds, the Hoeing could not hinder their Production, where the Soil was inclined naturally to produce them.

The Belief of that blind Doctrine might probably be one of the Cauſes, that made the Ancients deſpair of finding ſo great Succeſs in Hoeing, as now appears; or elſe, if they had had true Principles, they might perhaps have Invented and Improved that Husbandry, and the Inſtruments neceſſary to put it in Practice.

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(1) A very pernicious large Perennial-Weed, like *Burridge*, with a Blew Flower, infeſted a Piece of Land, for Time out of Mind; Hoeing has deſtroy'd it utterly, not one of the Species has been ſeen in the Field theſe ſeven Years, tho' conſtantly Till'd and Hoed.

(2) The Seeds of ſome Weeds may be ſuſpected to come in the Air; as the Seed of the Graſs that grew in *Cheap-ſide*, in the time of the Plague; But it might come from Seeds in the Dirt, brought thither by the Feet of People and Cattle, and by the Wheels of Coaches, Carts carrying Hay, or otherways: Continual Treading might keep it from growing, and when the Treading ceaſed, 'tis no wonder the Seeds ſhould furniſh the Streets with Graſs.

And I have obſerv'd on the Floors, Two Story high, of a lone, ruinous, uninhabited Houſe, being long uncover'd, a ſort of Herb growing very thick; I think it was *Pimpernel*, and believe that its Seeds did not come thither in the Air; but in the Sand which was mix'd with the Mortar that had fall'n from the Cielings, and 'tis like there were few Seeds at firſt, yet theſe ripening for ſeveral Years, ſhed their Seeds Annually, until the Floors became all over very thick planted: Beſides, Hay-Seeds and Pimpernel are too heavy to be carried far by the Air.

CHAP. IX.

REMARKS *on the* Bad HUSBANDRY, *that is ſo finely Expreſs'd in* *VIRGIL's* Firſt GEORGIC.

-----Terræ
Pingue ſolum primis extemplo à menſibus anni
Fortes invertant tauri: glebaſque jacentes
Pulverulenta coquat maturis ſolibus æſtas.

'-----Strait let the vig'rous Steer
' Turn the *Rich* Furrow, in the New-born Year,
' And Summer's Heat with rip'ning Suns purſue
' The Sluggiſh Glebe, and all the Clod ſubdue.

' ----*officiant lætis ne frugibus* herbæ;
' ----leſt the Weeds the ſmiling Blade withſtand.

This is *Virgil*'s Reaſon for Plowing Rich Land betimes, and ſhews the old Theory, which never gave any other Reaſon for Tillage, and Hoeing, except Killing of Weeds.

' *At ſi non fuerit tellus fœcunda, ſub ipſum*
' *Arcturum tenui* ſat erit *ſuſpendere ſulco:*

' But if not *fat* the Soil, it will ſuffice,
' When bright *Arcturus* mounts the purple Skies,
' To Skim the Surface with a gentle Share,
' And lift the Furrow lightly to the Air;

' ----*Sterilem exiguus ne deſerat* humor *arenam.*
' Leſt Moiſture ---deſert the Barren Sand.

He directs that poor Land ſhould be plow'd Late, for fear the Moiſture ſhould be Dry'd out of it.

This has more Need of being enrich'd by early and frequent Plowings; for all its Moiſture will be exhal'd, and for Want of being Open'd, can receive little return from the Atmoſphere, the later it's plow'd, the Dryer it will be.

The *Sat erit*, is therefore a great Miſtake.

Tenui Sulco, (a ſhallow Furrow) The Land being Steril requires, that it be plow'd as Deep as the Staple will allow; for the poorer it is, the leſs Reaſon is there to leave any part of it Unplow'd; and ſhallow plowings, tho' the Land be never ſo fine, loſe much of the Benefit that Dews bring to the Ground; becauſe the Earth being Hard below, will not ſuffer them to ſink ſo Deep, but that they are again exhal'd in the Day; this keeps it dryer and poorer.

The *Mutatis fœtibus*, and *Inaratæ Gratia terræ*, are anſwer'd in Chap. *Tillage*, and Chap. *Change of Species.*

' *Sæpe etiam ſteriles incendere profuit agros,*
' *Atque levem ſtipulam crepitantibus urere flammis.*

It profits oft to Fire the Fruitleſs Ground,
And thirſty Stubble crackling all around.

'Tis certain, that *Virgil* meant the Burning the Stubble upon Rich Land, and Burning the Turf it ſelf of Barren Land (1); becauſe Barren Land had no Stubble on it to be burnt; but the Cuſtom of Burning the Stubble, on the Rich Plains about *Rome*, continues to this Time, and the chief Benefit of it is, that by this means they are prevented from being an Incumbrance to the next plowing, and their Aſhes, together with the Dead bodies of Serpents, Lizards, &c. which the Flame kills, become a ſort of Compoſt (tho' a very light one, and next to nothing in quantity) or Manure to the Soil, which is only Warm'd, not Burnt.

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(1) Such Poor Land ought to be the oftner plow'd to Enrich it, by making it ſtill Finer, as the Salts which are left after Burning and Waſting the beſt part of that Poor Thin Land, being ſpread upon the barren Remainder, will ſo Divide even that, by Fermenting therewith, as to cauſe it to produce a few Crops; But this cannot be ſo much Divided, or Pulveriz'd by the Plow; unleſs the Plowings be oftner repeated than any Body has ever yet repeated them; and if ever any Trial be made

As to the other, *viz.* the Burning the Earth it ſelf of the Barren Fields, eſpecially of thoſe which have a ſhallow Staple, 'tis a Practice ſo pernicious, and carries away ſo much of the beſt part of the Surface, that 'tis not only (as far as I can be Inform'd) wholly left off in *Italy*, but in moſt other Countries, where the Owners of Lands have any Regard to Poſterity; for it certainly deſtroys thoſe thin poor Fields, and after a few Crops, renders them ſcarce worthy the Name of an *Inheritance*.

The Reaſons *Virgil* offers for explaining the Cauſe of this ſhort Improvement of Burning this barren Land, are ſuch, as abſtracted from the Poetry, will appear to be utterly unbecoming the Character of a Philoſopher, who pretends *Rerum cognoſcere Cauſas*. His are ſuch, that tho' contrary to one another, and Jarring among themſelves, are all of them Falſe, as,

Sive inde occultas vires, & pabula terræ
Pinguia concipiunt.

' Whether from thence by Nature's Secret Laws,
' Freſh Nouriſhment the Earth and Vigour draws.

This is ſo far from being true, that the Fire inſtead of *Giving* any ſort of Strength, or Nouriſhment

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made to attempt the Equalling theſe Aſhes, it will be beſt to do it by Way of Hoeing; becauſe a Crop is rais'd by it, at the ſame time, to help defraying the Expence of ſuch Trial. How frequent Hoeing brings Moiſture, ſee Chap. *Of Hoeing*.

ment to the Earth that is *Burnt*, *carries both away*, and brings nothing in room thereof. The great Decreaſe of its Weight (1) ſhews how much is miſſing.

----Sive illis omne per ignem
Excoquitur vitium, atque exudat inutilis humor.

'Or that the latent Vice is purg'd by Heat,
'And the redundant Humours waſte in Sweat.

There was no Vice in it, to be boil'd out, except its being ſtockt with Graſs, and wanting Tillage. Had there been Moiſture in it, it would not have burnt, therefore that muſt have been Dry'd out before the Fire could operate.

Seu plures calor ille vias, & cæca relaxat
Spiramenta, novas veniat qua ſuccus in herbas:

'Or, that the Flames unuſual Tracks explore,
'Relax the Grit, and open ev'ry Pore,
'Whence genial Moiſture haſtens through the (Earth,
'Slides to the Root, and chears the tender Birth.

It does indeed ſo relax and open the Earth, that all that is Fruitful Breaths out of it; the Fire makes Room enough for the Juice to reach Plants, but the Miſchief on't is, it leaves no Juice at all for them.

Seu durat magis, & venas aſtringit hiantes:
Ne tenues pluviæ, rapidive potentia ſolis
Acrior, aut Boreæ penetrabile frigus adurat.

'Or that the Heat the hollow Glebe conſtrains,
'Braces each Nerve, and knits the gaping Veins;

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(1) I am ſorry to find that Mr. *Evelyn* ſhould think, that an Intenſe Calcination of the Earth Increaſes the very Weight of the Mould; ſince even Stone burnt to Lime, loſes a Third part of its Weight by the Calcination; and Earth, being more ſulphureous, loſes more of its Weight by being Burnt, and viſibly emits more Smoak.

'Leſt piercing Wet, or the ſwift Power of Day,
'More fierce, or ſcorching *Boreas* urge his Way.

Hey day! This is both contrary to what he ſaid before of Relaxing and Opening, and to the Fact it ſelf; for Fire having reduc'd the Earth(that it leaves) to Aſhes, which are ſo Hollow, that Rain, Heat, and Cold will eaſily enter them; ſo Looſe that they will not become Hard or Denſe, all their *Cement* being gone.

'Tis common for the Rain to waſh them off from the Declivity of a Hill, and for the Wind to Blow them away from the Plain, they are ſo Light. And 'tis a *Demonſtration* of their *Sterility*, that no manner of Vegetable will grow, or live in them: So that the Poet had much better have ſolv'd this Phœnomenon by a poſitive ingenuous *Je ne ſcay quoy*; Or, to have left off at this Verſe, *viz.*

Effœtos cinerem immundum jactare per agros.

------nor oe'r th'exhauſted Sand
To ſpread vile Aſhes with a friendly Hand.

From obſerving the Effect of theſe impure Aſhes, he might have diſcover'd the Cauſe he ſo unfortunately aims at; for it can be no other than, that the Cinereal Salts being ſpread upon the unburnt Earth that is left, Ferment therewith, and reducing it into an almoſt infinite Number of Parts, increaſe proportionably that *Internal Superficies* deſcrib'd in Chap. *Of Paſture of Plants*; but if we would compute the Loſs we ſuſtain in Waſte and Diminution of the Staple of our Thin Land in Burning it, we ſhould find theſe Aſhes, a very Dear ſort of Compoſt; for tho' two or three good Crops are receiv'd after this Manure; whoſe Salts Divide more than common Plowing can do; yet the Land is become ſo Thin, that whereas 'tis impoſſible to Injure it ſo much by Crops obtain'd from fair Tillage, but that in a few Years, it will recover its Fertility; yet the Miſchief done by this Fire, will never ſuffer it to equal the ſame ſort of *Unburn'd* Land, until a general *Conflagration*.

Multum adeo, raſtris glebas qui frangit inertes,
Vimineaſque trahit crates, juvat arva:

Much too he helps the Field, who ev'ry Clod
With Harrows breaks, and drags the Hurdle's (Load.

This way of Tilling the Land with Harrows, recommended by the Poet, ſeems to ſhew his Huſbandry was degenerated from that of the old *Romans*, who ſaid, *Male ſubactum Agrum qui occandus ſit*. Col. That Field is ill Till'd that wants Harrowing.

A yet worſe Contrivance it was, to Till Land with a Hurdle made of Vine Twigs, this is ſo Puerile an Invention, that he might have directed it to be drawn by a Hobby-Horſe.

A late Commentator interprets this Harrowing and Hurdling, to be of Uſe in ſowing upon the Back; that is, upon Once Plowing; had this Interpretation been omitted, *Virgil* might have been thought not to have amaſs'd together every one of the very worſt Pieces of Huſbandry, that could be met with in any Age or Country.

Rurſus in obliquium (1) *verſo perrumpit aratro.*

Aſſails oblique, and thorough cuts again.

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(1) Whilſt the Green-ſide of the Furrow, which is turn'd downwards by the firſt Plowing, is Rotting, the Root-ſides being upwards, ſends up Blades and Stalks of Graſs from all the Joints of Roots expos'd to the Air; for every Joint has both Roots

This is found not to attain the End of Tillage near ſo well, as Turning the Furrows back again into the ſame Places, where they were before breaking up, and not to Plow croſs the Furrows until the Third Plowing; this ſhews, that in thoſe Days *Ceres* did chuſe her Favourites as many are now choſen, not for their Merits; ſince the moſt ſlovenly Huſbandmen were honour'd with her Approbation.

Humida Solſtitia atque hyemes orate ſerenas
Agricolæ: ----

The Solſtice moiſt, ſerene the Winter Sky,
For this, ye Swains, intreat the Powers on high.

Here he might have adviſed them to remedy, in ſome Meaſure, the Inconveniencies of dry Weather, by frequently Hoeing the Soil to open it, for the Reception of the Dews which moiſten it, and refrigerate the Roots in the Night, after the ſcorching Heat of the Day: Since he knew that

Noctes lentus non deficit humor.

Diſtilling Moiſture ne'er deſerts the Night.

He might have adviſed an Expedient to obtain in part the Effects of *Hiemes ſerenæ*, *viz.* To plant the Corn in ſuch a manner, that it might be protected

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Roots and Stalks included in it, the open Air kills the Roots; but the Stalks are kill'd for want of it; theſe revers'd Roots being become a new Turf, (which is nouriſhed by ſuch Roots as the Thickneſs and Largeneſs of the Furrow protect from Air) will continue to Grow and hold the Earth together, until that be alſo turn'd downwards from the Reach of the Air: But in Croſs-Plowing, not half the Furrows are turn'd, they are only heap'd up upon one another, and there the Air keeps the Graſs alive for a long time; when that which is turn'd back the ſame way without Croſſing is all kill'd; and being Dead on both ſides will grow no more; and the Land is much ſooner brought into Tilth this way, than by Croſs-Plowing, as Experience ſhews.

from the Injuries of cold Winds and Water, as in the Chap. of *Wheat* is deſcribed.

Ipſa dies alios alio dedit ordine Luna
Felices operum. Quintam fuge: &c. (1)

For various Labours each revolving Moon
Gives happy Days; the Fifth be ſure to ſhun.

Is this what the late Commentator in his Preface calls, An Appeal to Truth and Nature throughout all Ages of Mankind? Muſt vain and idle Superſtition be thought Truth and Natural, becauſe 'tis *Old*, tho' we know it to be Falſe, and conſequently againſt Nature? I'm ſure 'tis far from ſhewing, that the Foundation of the whole *Georgic* is Truth; unleſs he left out this, and moſt of all the reſt: For indeed I cannot find, One *new* uſeful Truth diſcover'd in all the Pages of the *Georgic* (2), tho' he ſays, every Page affords Inſtances of ſuch; therefore I agree with that Commentator, that 'tis endleſs to enumerate Inſtances of that kind; becauſe I hold, that *Nothing cannot be number'd*.

Hic ſegetes, illic veniunt felicius Uvæ:

The *Harveſt* Here, There *Vines* more happy (found.

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(1) Black-Acre is firſt ſown, and on the right Day of the Moon to begin upon; then continuing to ſow, till in its Turn White-Acre is ſown, on the Worſt Day of the Moon: Now what Reaſon could the Poet give, why White-Acre, ſown on the Worſt Day, ſhould proſper the better for Black-Acre's being ſown on the Beſt Day? Anſwer: his Word; for certainly no other Oracle, but *Virgil*'s Word, could have obtain'd a Place for any thing ſo Unphiloſophical as this (about the Days of the Moon) to ſtand among the Tranſactions of that illuſtrious Society, whoſe Motto is *Nullius in Verba*.

(2) The natural Habit of Truth is a plain Dreſs: yet not ſuddenly found, being the Daughter of Time, therefore the Moderns have the Advantage of the Ancients.

Vines will grow as well, and better in ſtrong Land, but light Land is more eaſily Hoed, &c.

Vines will grow where ever Corn will grow, if there be ſufficient Heat to ripen the Grapes: And Corn will grow where ever Vines will.

Nonne vides, croceos ut Tmolus Odores,
India mittit Ebur, &c.

Do you not ſee how *Tmolus* his Perfumes,
Her Iv'ry *India*, ſoft *Sabæans* Gums,
How *Pontus* heady Caſtor ſends from far,
The *Spaniard*'s Steel,----

Should any Author in Proſe, have given a Caution to the *Italian* Farmers againſt planting their Lands with Perfumes, Ivory, Frankincenſe, Caſtor or Steel; would he not be thought very Impertinent?

A late Commentator upon *Virgil*'s ſecond *Georgic* ſays (1), ‘ He is certain the Husbandry of *England* ‘ in general is *Virgilian*, which is ſhewn by the Paring ‘ and Burning the Surface; by Raftering, or Croſs ‘ Plowing; and that in thoſe Parts of *England*, which ‘ the *Romans* principally Inhabited, all along the ‘ Southern Coaſt, Latin Words remain to this Hour ‘ among Shepherds and Plowmen in their Ruſtick ‘ Affairs; and what will ſeem more ſtrange at firſt ‘ ſight to affirm, tho' in Fact it be really true, There ‘ is more of *Virgil*'s Husbandry put in Practice in ‘ *England* at this Inſtant, than in *Italy* it ſelf.

It's my Opinion, that the *Italians*, in Changing *Virgil*'s Field Husbandry (2), have acted more reaſonably than theſe *Engliſh* who retain it; becauſe I think it impoſſible for any Scheme in general to be Worſe. Mine Differing from it in all reſpects, warrants me in calling mine *Anti-Virgilian.*

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(1) In the Preface to his Tranſlation of the Second *Georgic*, Page XVI.

(2) When *Virgil* ſays, ——*Glebaque verſis*
Æternum frangenda Bidentibus.
He treats only of the Vineyard Culture, not of the Field Huſbandry.

Chap. X. *Of TURNEPS.*

As far as I can be inform'd, 'tis but of late Years that Turneps have been introduc'd as an Improvement in the Field.

All ſorts of Land, when made fine by Tillage, or by Manure and Tillage, will ſerve to produce Turneps, but not equally; for Chalky Land is generally too Dry (a Turnep being a Thirſty Plant) and they are ſo long in ſuch dry poor Land before they get into Rough Leaf, that the Fly is very apt to deſtroy them there; yet I have known them ſucceed on ſuch Land, tho' rarely.

Sand and Gravel are the moſt proper Soil for Turneps; becauſe that is moſt eaſily pulveriz'd, and its Warmth cauſes the Turneps to grow faſter, and ſo they get the ſooner out of Danger of the Fly; and ſuch a Soil, when well Till'd, and Horſe-hoed, never wants a ſufficient Moiſture, even in the Drieſt Weather, and the Turneps being Drill'd, will come up without Rain, and proſper very well with the ſole Moiſture of the Dews, which are admitted as Deep as the Pulveration reacheth; and if that be to five or ſix Inches, the hotteſt Sun cannot Exhale the Dews thence in the Climate of *England:* I have known Turneps Thrive well in a very Dry Summer, by repeated Horſe-Hoeings, both in Sand, and in Land which is neither Sandy, nor Gravelly.

When I ſowed Turneps by Hand, and Hoed them with a Hand-Hoe, the Expence was great, and the Operation not half perform'd, by the Deceitfulneſs of the Hoers, who left half the Land unhoed, and cover'd it with the Earth from the Part they did Hoe, and then the Graſs and Weeds grew the faſter: Beſides in this manner a great Quantity of Land could not be managed in the proper Seaſon.

When I Drill'd upon the Level (1), at three Foot Intervals, a Trial was made between thoſe Turneps and a Field of the next Neighbour's, ſown at the ſame time, whereof the Hand-Hoeing coſt Ten Shillings *per* Acre, and had not quite half the Crop of the Drill'd, both being meaſur'd by the Buſhel, on purpoſe to find the Difference (2).

In the new Method they are more certain to come up quickly; becauſe in every Row, Half the Seed is planted about Four Inches Deep (3), and the other Half is planted exactly over that, at the Depth of Half an Inch, falling in after the Earth has cover'd the firſt Half: thus planted, let the Weather be never ſo Dry, the deepeſt Seed will come up; but if it Raineth (immediately after planting) the ſhallow will come up firſt; we alſo make it come up at Four (1) times, by mixing our Seed, half New, and half Old (the New coming a Day quicker than the Old) theſe four Comings up, give it ſo many Chances for eſcaping the Fly, (it being often ſeen, that the Seed ſown over Night will be deſtroy'd by the Fly, when that ſown the next Morning will eſcape; and *vice verſa*; (2) or you may Hoe-plow them, when you ſee the Fly is like to devour them; this will bury the greateſt part of thoſe Enemies; or elſe you may Drill in another Row, without new plowing the Land.

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(1) 'Tis impoſſible to Hoe-Plow them ſo well when planted upon the Level, as when they are planted upon Ridges; for if we plow deep near to the Row, the Earth will come over on the Left-ſide of the Plow, and bury the young Turneps; but when they ſtand on Ridges, the Earth will almoſt all fall down on the Right-ſide into the Furrow in the middle of the Interval.

(2) And I have ſince found, that Turneps on the ſame Land, planted on Ridges, with Six-Foot Intervals, make a Crop double to thoſe that are planted on the Level, or even on Ridges with Three-Foot Intervals.

(3) Turnep-Seed will come up from a greater Depth than moſt other ſorts of Seeds.

This Method has alſo another Advantage of Eſcaping the Fly, the moſt certain of any other, and Infallible, if the Land be made fine as it ought to be; this is to Roll it with a Heavy Roller a-croſs the Ridges, after 'tis Drill'd, which cloſing up the Cavities of the Earth, prevents the Fly's Entrance and Exit, to lay the Eggs, Hatch, or bring forth the Young ones to prey upon the Turneps, which they might entirely devour if the Fly came before they had more than the firſt two Leaves, which being form'd of the very Seed itſelf, are very ſweet; but the next Leaves are Rough and Bitter, which the Fly does not love: I have always found the Rolling diſappoint the Fly, but very often it diſappoints the Owner alſo, who ſows at Random; for it makes the Ground ſo hard, that the Turneps cannot thrive; but look Yellow, dwindle, and grow to no Perfection, unleſs they have a good Hoeing ſoon after the Rough Leaves appear; for when they ſtand long without it, they will be ſo poor and ſtunted, that the Hand-Hoe does not go deep enough to recover them; and 'tis ſeldom that theſe Rolled Turneps can be Hand-Hoed at the Critical Time; becauſe the Earth is then become ſo hard, that the Hoe will not enter it, without great Difficulty, unleſs it be very moiſt, and very often the Rain does not come to ſoak it until it be too late; but the Drill'd Turneps being in ſingle Rows, with Six foot Intervals, may be Roll'd without Danger: For be the Ground never ſo hard, the Hand-Hoe will eaſily ſingle them out, at the Price of Six-pence *per* Acre or leſs (if not in Harveſt) and the Horſe-Hoe will in thoſe wide Intervals, plow at any time, wet or dry; and tho' the Turneps ſhould have been neglected till ſtunted, will go deep enough to recover them to a flouriſhing Condition.

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(1) I have ſeen Drill'd Turnep-Seed come up Daily for a Fortnight together, when it has not been mixt thus, the Old with the New.

(2) I have had the firſt Turneps that came up, all deſtroy'd by the Fly, and about a Fortnight afterwards more have come up, and been Hoed time enough and made a good Crop.

Drill'd Turneps, by being no where but in the Rows, may be more eaſily ſeen than thoſe which come up at Random, and may therefore be ſooner ſingled out by the Hand-Hoe; which is another Advantage; becauſe the ſooner (1) they are ſo ſet out, the better they will thrive.

Three or Four Ounces of Seed is the uſual Quantity to Drill; but at Random, Three or Four Pound is commonly ſown, which coming thick all over the Ground, muſt exhauſt the Land more than the other, eſpecially ſince the ſown muſt ſtand longer, before the Hoers can ſee to ſet them out.

The Six-Foot Ridges, whereon Turneps are Drill'd in ſingle Rows, may be left higher than for double Row'd Crops; becauſe there will be more

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(1) The ſooner they are made Single the better; but yet, when they are not very thick, they may ſtand till we have the beſt Convenience of Singling them, without much Damage; but when they come up extraordinary thick, 'twill be much more difficult to make them ſingle, if they are neglected at their very firſt coming into Rough Leaf.

Earth in the Intervals, as the ſingle Row takes up leſs.

There is no prefix'd Time for planting Turneps, becauſe that muſt be according to the Heat or Richneſs of the Land; for ſome Land will bring them as forward, and make them as good, when planted the Beginning of *Auguſt*, as other Land will when planted in *May*; but the moſt general Time is a little before, and a little after *Midſummer*.

Between theſe Rows of Turneps, I have planted Wheat in this manner, *viz.* About *Michaelmas*, the Turneps being full grown, I plow'd a Ridge in the Middle of each of their Intervals, taking moſt of the Earth from the Turneps, leaving only juſt enough to keep them alive; and on this Ridge Drill'd my Crop of Wheat (1), and towards the Spring pull'd up my Turneps, and carry'd them off for Cattle.

When Turneps are planted too late, to have Time and Sun for attaining to their full Bulk, ſome Drill a double Row, on each Six-Foot Ridge, with a Partition of Fourteen Inches; but I am told, that in this double Row the Turneps do not, even at that late Seaſon, grow ſo large, as thoſe planted at the ſame time in ſingle Rows; tho' the double Row requires double the Expence in ſetting out; and there will be leſs Earth Hoed by the Breadth of Fourteen Inches of the deepeſt part of the Ridge; and conſequently the Land will be the leſs improv'd for the next Crop. We need not to be very exact, in the Number (1) or Diſtance (2) we ſet them out at: We contrive to leave the Maſter-Turneps, (when there is much Difference in them) and ſpare ſuch when near one another, and leave the more Space before and behind them; but if they be Three Maſter-Turneps too near together, we take out the Middlemoſt.

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(1) This Wheat, being thus Drill'd on the new Ridges, made in the Intervals, betwixt the Rows of Turneps, being well Horſe-Hoed in the Spring, prov'd a very good Crop; it was Drill'd in Treble Rows, the Partitions ſeven Inches each.

Turneps that were ſo thick as to touch one another when half grown, by means of well Hoeing their wide Intervals, have afterwards grown to a good Bigneſs, and by thruſting againſt one another became Oval inſtead of Round.

'Tis beneficial to Hoe Turneps (eſpecially the firſt Time) alternately, *viz.* to Hoe every other Interval, and throw the Earth back again, before we Hoe the other Intervals; for by this means the Turneps are kept from being ſtunted; 'tis better to have Nouriſhment given them moderately at Twice, than to have it all at once, and be twice as long before a repetition (3).

Tho' the Earth on each ſide the Row be left as narrow as poſſible (4), yet 'tis very profitable to Hoe that little with a Bidens (5), called here a

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(1) The leaſt Number will be the largeſt Turneps, yet we ſhould have a competent Stock, which I think is not leſs than Thirty on a ſquare Perch.

(2) The Diſtance need not to be regular; for when a Turnep has Six Inches of room on One ſide, and Eighteen Inches on the other ſide, 'tis almoſt as well as if there was one Foot on each ſide; tho' then it would be equally diſtant from the Two Turneps betwixt which it ſtood.

(3) Sometimes when Turneps are planted late, this Alternate Hoeing ſuffices, without any Repetition; but when they are planted early, 'twill be neceſſary to Hoe them again; eſpecially if Weeds appear.

(4) I do not think that we can go nearer to the Plants with the Hoe-Plow, than within Three Inches of their Bodies.

(5) We ought not to uſe the Bidens for this purpoſe, before the perpendicular Roots are as big as one's little Finger.

Prong-Hoe, for this will be ſure to let out all the Roots, into the Intervals, even ſuch as run very nearly Parallel to the Rows.

This Alternate way of Hoeing Plants, that grow in ſingle Rows, is of ſuch vaſt Advantage, that Four of theſe, which are but equal to Two of the *whole* Hoeings in Labour, are near equal to Four *whole* Hoeings in Benefit; for when one ſide is well nouriſhed, the other ſide cannot be ſtarv'd (1).

Beſides, where a great Quantity of Turneps are to be Hoed, the laſt Hoed may be ſtunted, before the firſt are finiſhed by *whole* Hoeings.

In this Alternate Hoeing, the Hoe-Plow may go deeper (2), and nearer to the Row, without danger of thruſting it down on the left ſide, whilſt the Plants are very ſmall; becauſe the Earth on the other ſide of the Row, always bears againſt it for its Support: But in the *whole* Hoeing, there is an open Furrow left the firſt time on both ſides of the Row, and there is Danger of throwing it into one Furrow in plowing the other; or if the Row is not thrown down, it may be too much dry'd in hot Weather, by the Two Furrows lying too long Open: Yet when the Turneps are large before Hoeing, we need not fear either of theſe Dangers, in giving them a *whole* Hoeing; as I have found by Experience, even when there has been left on each ſide of the Row, only about Three Inches Breadth of Earth; tho' it is not beſt to ſuffer it to lie long Open (1).

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(1) But yet ſometimes the Weeds, or other Circumſtances, may make it proper to give them a *whole* Hoeing at firſt.

(2) This Deep Plowing, ſo dear to the Row, is very beneficial at firſt; but afterwards when the Plants are grown large, and have ſent their Roots far into the Intervals, it would almoſt totally diſ-root them; and they being Annuals, might not Live long enough for a new ſtock of Roots to extend ſo far as is neceſſary, to bring the Turneps to their full Bigneſs.

Note. At the laſt Hoeing, we generally leave a Broad Deep Trench in the Middle of each Interval.

Dry Weather does not injure Turneps when Horſe-Hoed, as it does ſown Turneps; the Hand-Hoe does not go deep enough to keep the Earth moiſt, and ſecure the Plants againſt the Drought; and that is the beſt Seaſon for Horſe-Hoeing, which can always keep the Roots Moiſt.

Dung and Tillage together, will attain the neceſſary Degree of Pulveration, in leſs time than Plowing can do alone; therefore Dung is more uſeful for Turneps; becauſe they have commonly leſs time to grow, than other Plants.

Turneps of Nineteen Pounds weight I have ſeveral times heard of, and of Sixteen Pounds weight often known; and Twelve Pounds may be reckon'd the middle ſize of great Turneps: And I can ſee no Reaſon, why every Turnep ſhould not arrive to the full Bigneſs of its Species, if it did not want Part of its due Nouriſhment.

The greateſt Inconvenience, which has been obſerv'd in the Turnep-Husbandry, is when they are Fed off late in the Spring (which is in many Places the greateſt Uſe of them) there is not Time to bring the Land in Tilth for Barley, the Loſs of which Crop, is ſometimes more than the Gain of the Turneps: this is entirely remedied by the Drilling Method; for by that, the Land may be almoſt as well Till'd before the Turneps are eaten, or taken off, as it can afterwards.

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(1) But if the Weather prove Wet, we always ſuffer thoſe Furrows to lie Open until the Earth be dry enough to be turn'd back again to the Row, without ſmearing or ſticking together; unleſs ſuch Weather continues ſo long, that the Weeds begin to come up, and then we throw back the Furrows to ſtifle the Weeds, before they grow large, tho' the Earth be wet.

If Turneps be ſown in *June*, or the Beginning of *July*, the moſt experienc'd Turnep-Farmers, will have no more than Thirty to a ſquare Perch left in Hand-hoeing, and find that when more are left, the Crop will be leſs; but in Drilling the Rows at ſix Foot Intervals, there may be ſixty (1) to a Perch; and the Horſe-hoe, by breaking ſo much more Earth than the Hand-hoe does, can Nouriſh ſixty Drill'd, as well as thirty are by the ſowing Method, which has been made appear upon Trial; but, I think, about forty or forty-five better than ſixty on a Perch; and the Number of Plants ſhould always be proportion'd to the Natural and Artificial Paſture, which is to maintain them; and ſixty Turneps on a ſquare Perch, at five Pound each (which is but a Third of the Weight of the large ſize of Sheep-Turneps) make a Crop of above eighty Quarters to an Acre(2).

When Turneps are planted late (eſpecially upon poor Ground) they may be a greater Number than when planted early; becauſe they will not have time enough of Heat to enjoy the full Benefit of Hoeing, which would otherwiſe cauſe them to grow larger.

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(1) Yet I think Sixty too many, unleſs the Soil be Rich, and very well pulveriz'd.

(2) I have had Turneps upon poor undung'd Land that weighed Fourteen Pound a Piece; but theſe were only ſuch as had more room than the reſt. I have ſeen a whole Waggon-Load of Drill'd Turneps ſpread on the Ground, wherein I believe one could not have found One that weighed ſo little as ſix Pound; or if the Rows had been ſearched before they had been pull'd up, they would have weighed ſeven or eight Pound a piece one with another; we weighed ſome of them that were thirteen, ſome Fourteen Pound each, and yet they ſtood pretty thick. There might be, as I gueſs, about Fifty on a ſquare Perch; but this Crop was on Sandy Land not Poor, and was Dung'd the third or fourth Year before, and had every Year a Hoed Crop of Potatoes, or Wheat, until the Year wherein the Turneps were planted.

The greateſt Turnep-Improvement uſed by the Farmer, is for his Cattle in the Winter, One Acre of Turneps will then maintain more than Fifty of Meadow, or Paſture-Ground.

'Tis now ſo well known, that moſt Cattle will eat them, and how much they breed Milk, &c. that I need ſay nothing about it.

Sheep always refuſe them at firſt, and unleſs they have eaten them whilſt they were Lambs, muſt be ready to ſtarve, before they will feed on them; tho' when they have taſted them, they will be fatted by them: and I have ſeen Lambs of three Weeks old, ſcoop them prettily, when thoſe of a Year old (which are called Tegs) have been ready to die with Hunger amongſt them; and for three or four Days would not touch them, but at laſt eat them very well.

In ſome Places the greateſt Uſe of Turneps (except for fatting Oxen and Sheep) is for Ews and Lambs in the Spring, when natural Graſs is not grown on poor Ground; and if the artificial Graſs be then fed by the common manner, the Crop will be ſpoil'd; and it will yield the leſs Paſture all the Summer: I have known Farmers, for that Reaſon, oblig'd to keep their Ews and Lambs upon Turneps (tho' run up to Seed) even until the Middle of *April*.

There are now Three Manners of Spending Turneps with Sheep, amongſt which I do not reckon the Way of putting a Flock of Sheep into a large Ground of Turneps without dividing it; for in that Caſe the Flock will deſtroy as many Turneps in a Fortnight, as would keep them well a whole Winter.

The firſt Manner now in uſe is, To divide the Ground of Turneps by Hurdles, giving them leave to come upon no more at a time than they can eat in one Day, and ſo advance the Hurdles further into the Ground daily, until All be ſpent; but we muſt obſerve, that they never eat them clean this Way, but leave the Bottoms and Outſides of the Turneps, they have ſcoop'd, in the Ground. Theſe Bottoms, People pull up with Iron Crooks, made for that purpoſe; but their Cavities being tainted with Urine, Dung, and Dirt from their Feet, tho' the Sheep do eat ſome of the Pieces, they waſte more, and many the Crooks leave behind in the Earth; and even what they do eat of this tainted Food, can't nouriſh them ſo well as that which is freſh and cleanly.

The Second Manner is, To Move the Hurdles every Day, as in the Firſt; but that the Sheep may not tread upon the Turneps, they pull them up firſt, and then advance the Hurdles as far daily, as the Turneps are pull'd up, and no farther; by this means there is not that Waſte made as is in the other Way, the Food is eaten freſh and clean, and the Turneps are pull'd up with leſs Labour than their Pieces can be (1).

The Third Manner is, To pull them up, and to carry them into ſome other Ground in a Cart, or Waggon, and there ſpread them every Day, on a New Place, where the Sheep will eat them up clean, both Leaf and Root: This is done when there is Land not far off, which has more Need of Dung, than that where the Turneps grow, which perhaps is alſo too wet for Sheep in the Winter, and then the Turneps will, by the too great Moiſture and Dirt of the Soil, ſpoil the Sheep, and in ſome Soils give them the Rot; yet ſuch Ground will bring forth more and larger Turneps than Dry Land; and when they are carry'd off and eaten on plow'd Ground in dry Weather, and on Green-ſwerd in wet Weather, the Sheep will thrive much better; and that moiſt Soil, not being trodden by the Sheep, will be in much the better Order for a Crop of Corn. And generally the Expence of Hurdles, and Removing them being ſaved, will more than countervail the Labour of carrying off the Turneps.

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(1) I have ſeen Three Labourers work every Day with their Crooks, to pull up theſe Pieces, which was done with much difficulty, the Ground being trodden very hard by the Sheep; when one Perſon, in Two Hours Time, would have pull'd up all the *whole* Turneps daily, and the Sheep would have eaten them clean; but ſo many of thoſe Pieces were dry'd and ſpoil'd, that after the Land was ſown with Barley, they appear'd very thick upon the Surface, and there could not be much leſs than Half the Crop of Turneps waſted, notwithſtanding the Contrivance of theſe Crooks.

Theſe Three Ways of ſpending Turneps with Sheep are common to thoſe Drill'd, and to thoſe Sown in the Random manner; but they muſt always be carry'd off for Cows and Oxen; both which will be well fatted by them, and ſome Hay in the Winter; the Management of theſe is the Buſineſs of a Grazier.

Chap. XI. Of WHEAT.

THO' all ſorts of Vegetables may have great Benefit from the Hoe, becauſe it ſupplies them with Plenty of Food, at the time of their greateſt Need, yet they do not all equally require Hoeing; but the Plant that is to live the longeſt, ſhould have the largeſt Stock of Suſtenance provided for it: generally Wheat lives, or ought to live, longer than other ſorts of Corn; for if it be not ſown before Spring, its Grain will be thin, and have but little Flour in it, which is the only uſeful part for making Bread.

And when ſown late in the Winter, 'tis in great Danger of Death from the Froſt, whilſt weak and tender, being maintain'd (as a Fœtus) by the umbilical Veſſels, until the Warmth of the Sun enables it to ſend out ſufficient Roots of its own to ſubſiſt on, without help of the *Ovum.*

To prevent theſe Inconveniencies, Wheat is uſually ſown in Autumn, hence having about Thrice the time to be maintain'd that Spring Corn hath, it requires a larger Supply of Nouriſhment, in proportion to that longer time; not becauſe the Wheat in its Infancy conſumes the Stock of Food, during the Winter, proportionably to what it does afterwards; but becauſe, during that long Interval betwixt Autumn and Spring Seed-times, moſt of the Artificial Paſture is Naturally loſt, both in light and in ſtrong Land.

For this very Reaſon is that extraordinary pains of Fallowing and Dunging the Soil, neceſſary to Wheat; tho' notwithſtanding all that Labour and Expence, the Ground is generally grown ſo ſtale by the Spring, and ſo little of the Benefit of that chargeable Culture remains, that, if part of the ſame Field be ſown in the Beginning of *April*, upon freſh plowing, without the Dung or Year's Fallow, it will be as great or a greater Crop, in all reſpects, except the Flour, which fails only for want of Time to fill the Grain.

Poor light Land, by the common Husbandry, muſt be very well cultivated and manur'd, to maintain Wheat for a whole Year, which is the uſual Time it grows thereon; and if it be ſown late, the greateſt part of it will ſeldom ſurvive the Winter, on ſuch Land; and if it be ſown very early on ſtrong Land, tho' rich, well till'd and dung'd, the Crop will be worſe than on the poor light Land ſown early. So much do the long Winter's Rains cauſe the

Earth to ſubſide, and the divided parts to coaleſce and lock out the Roots from the Stock of Proviſion, which tho' it was laid in abundantly at Autumn, the Wheat has no great occaſion of, until the Spring, and then the Soil is become too hard for the Roots to penetrate; and therefore muſt ſtarve (like *Tantalus*) amidſt Dainties, which may tempt the Roots, but cannot be attain'd by them.

But the New Method of Hoeing gives, to ſtrong and to light Land, all the Advantages, and takes away all the Diſadvantages of both, as appears in the Chapters of *Tillage* and *Hoeing*. By this Method the ſtrong Land may be planted with Wheat as early as the light (if plow'd dry) and the Hoe-Plow can, if rightly apply'd, raiſe a Paſture to it, equal to that of Dung in both ſorts of Land.

About the Year 1701, when I had contrived my Drill for planting St. Foin, I made uſe of it alſo for Wheat, drilling many Rows at once, which made the Work much more compendious, and perform'd it much better than Hands could do, making the Channels of a Foot diſtance, drilling in the Seed and covering it, did not in all amount to more than Six-pence *per* Acre Expence, which was above ten times overpaid by the Seed that was ſaved; for One Buſhel to an Acre was the Quantity drill'd; there remain'd then no need of Hand-work, but for the Hoeing; and this did coſt from Half a Crown to Four Shillings *per* Acre. This way turn'd to a very good Account, and in conſiderable Quantities; it has brought as good a Crop of Wheat on Barley Stubble, as that ſown the common way on Summer Fallow; and when that ſown the old way, on the ſame Field on Barley Stubble, entirely fail'd, tho' there was no other Difference but the Drilling and Hoeing. It was alſo ſuch an Improvement to the Land, that when one part of a ſtrong whitiſh Ground, all of equal Goodneſs, and equally Fallow'd and Till'd, was dung'd and ſown in the common Manner, and the other part was thus drill'd and Hand-Hoed without Dung, the Hoed part was not only the beſt Crop, but the whole Piece being Fallow'd the next Year, and ſown all alike by a Tenant, the Hoed part produc'd ſo much a better Crop of Wheat than the dung'd part, that a Stranger would have believ'd by looking on it, that that part had been dung'd which was not, and that part not to have been dung'd which really was.

Scarce any Land is ſo unfit, and ill prepar'd for Wheat, as that where the natural Graſs (1) abounds, moſt other ſorts of Weeds may be dealt withal when they come among Drill'd Wheat; but 'tis impoſſible to extract Graſs from the Rows, therefore let that be kill'd before the Wheat be planted.

The Six-Foot Ridges being Eleven, or Sixty-ſix Foot, which is a Acre's Breadth, ought to be made Length-ways of the Field, if there be no Impediment againſt it; as if it be a Hill of any conſiderable Steepneſs, then they muſt be made to run up and down, whether that be the Length or Breadth of the Piece; for if the Ridges ſhould go croſs ſuch a Hill, they could not be well Horſe-hoed; becauſe it would be very difficult to turn a Furrow upwards, cloſe to the Row above it, or to turn a Furrow downwards, without burying the Row below it; and even when a Furrow is turn'd from the lower Row, enough of the Earth to bury that Row will be apt to run over on the left ſide of the Plow; unleſs it goes at ſuch a Diſtance from the Row, as to give it no Benefit of Hoeing.

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(1) One Bunch of natural Graſs, Traſplanted by the Plow into a Treble Row of Wheat, will deſtroy almoſt a whole Yard of it.

Theſe Ridges ſhould be made ſtraight and equal, and to make them ſtraight (1) all good Plowmen know how; and they will by ſetting up Marks to look at, plow in a Line like the Path of an Arrow: But to make the Ridges equal, 'tis neceſſary to mark out a Number of them, before you begin to plow, by ſhort Sticks ſet up at each End of the Piece, and then if one Ridge happen to be a little too broad, the next may be made the narrower; for if the Plow comes not out exactly at the ſecond Stick, the two Ridges may be made equal by the next Plowing or by the Drilling; but if many contiguous Ridges ſhould be too wide or too narrow, 'twill be difficult to bring them all to an equality afterwards, without levelling the whole Piece, and laying out the Ridges all anew.

The exact Height of Ridges which is beſt I cannot determine (2), a different Soil may require a different Height, according to the Depth, Richneſs, and Pulveration of the Mould. As Wheat covets always to lie dry in the Winter, ſo there is no other way to keep it ſo dry as theſe Ridges; for when they are after the firſt Hoeing about Eighteen Inches broad, with a Ditch on each ſide, of almoſt a Foot deep, the Rain-Water runs off ſuch narrow Ridges as faſt as it falls, and much ſooner (1) than 'tis poſſible for it to do from broad Ridges.

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(1) But if the Piece be of ſuch a crooked or Serpentine Form, that the Ridges cannot well be plow'd ſtreight the firſt Time, 'tis beſt to Drill it upon the Level; and then the Marking Wheels may direct for making the Rows all parallel and equidiſtant, which will guide the Plow to make all the Ridges for the next, and all the ſubſequent Crops as equal.

(2) I find by meaſuring my Wheat Ridges in the Spring, that none of them are quite a Foot High; and ſome of them only Six Inches; but I know not how much they have ſubſided in the Winter; for they were certainly Higher when firſt made.

And the deeper the Soil, the more occaſion there commonly is of this high Situation; becauſe ſuch Land is wetter, for the moſt part, than ſhallow Land, where we cannot make the Furrows ſo deep, nor the Ridges ſo high (2), as in deep Land; for we muſt never plow below the Staple. I ſee the Wheat on theſe Hoed Ridges flouriſh, and grow vigorouſly in wet weather, when other Wheat looks yellow and ſickly.

The ſame wide Interval, which is Hoed betwixt Ridges the firſt Time, with two Furows, muſt have had four Furrows to Hoe it on the Level; or elſe the Furrow, that is turn'd from the Row, would riſe up, and a great part of it fall over to the left Hand, and bury the Row; but when turn'd from a Ridge, it will all fall down to the right Hand.

You muſt not leave the Tops of the Ridges quite ſo narrow and ſharp for Drilling of Wheat, as you may for Drilling Turneps; Wheat being in Treble Rows, but Turneps generally in ſingle Rows (3). This is our Method of making Ridges for the firſt Crop of Drill'd Wheat.

But the Method of making Ridges for a ſucceeding Crop, after the former is Harveſted, is beſt perform'd as follows: In making Ridges for Wheat after Wheat, you muſt raiſe them to their full Height, before you plow the old Partitions, with their Stubble, up to them; for if you go about to make the Ridges higher afterwards, the Stubble will ſo mix with the Mould of their Tops, that it may not only be a Hindrance to the Drill, but alſo to the firſt Hoeing; becauſe if the How-Plow goes ſo near to the Rows as it ought, it would be apt to tear out the Wheat-Plants along with the Stubble.

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(1) Water, when it runs off very ſoon, is Beneficial, as is ſeen in water'd Meadows; but where it remains long on, or very near the Bodies of Terreſtrial Plants, it Kills them, or at leaſt is very Injurious to them.

(2) If we ſhould make our Ridges as High on a ſhallow Soil, as we may on a deep Soil, there would be a Deficiency of Mould in the Intervals of equal Breadth with thoſe of a deep Soil.

(3) A ſingle Row taking up leſs of the Breadth, may be afforded to have more of the Ridge's Depth; becauſe it leaves the Interval Wider.

In Reaping, we cut as near as we can to the Ground (1), which is eaſily done, becauſe the Stalks ſtand all cloſe together at Bottom, contrary to thoſe of ſown Wheat.

I find this Stubble, when 'tis only mixt with the Intervals, very beneficial to the Hoeing of my Wheat; but I know not whether it may be ſo in Rich Miry Land.

As ſoon as conveniently you can, after the Crop of Wheat is carry'd off (if the Trench in the Middle of each wide Interval be left Deep enough by the laſt Hoeing) go as near as you can to the Stubble with a common Plow, and turn two large Furrows into the Middle of the Interval, which will make a Ridge over the Place where the Trench was: But if the Trench be not deep enough, go firſt in the Middle of it with one Furrow; which, with two more taken from the Ridges will be three Furrows in each Interval; continue this Plowing as long as the dry Weather laſteth; and then finiſh, by turning the Partitions (whereon the laſt Wheat grew) up to the new Ridges, which is uſually done at Two great Furrows. You may plow theſe laſt Furrows, which compleat the Ridges, in wet Weather.

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(1) When the Wheat is reap'd very low, the Stubble is no great Impediment; and I do this when I am forc'd to enlarge the Breadth of my Ridges, or to change their Bearing, as I do when I find it convenient for them to point Croſs ways of the Field inſtead of Length-ways; as if one End of it be wetter than the other; For 'tis inconvenient, that one End of a Ridge ſhould be in the wet Part, and the other in the dry; becauſe, in that Caſe, we cannot Hoe the dry end without Hoeing the wet at the ſame time; and whilſt we attend for the wet part to become dry, it may happen, that the Seaſon for Hoeing the Whole (if the Quantity be great) may be loſt.

To make a Six-Foot Ridge very high, will ſometimes require more Furrows; as when the Middle of the Intervals are open very wide and deep, then Six Furrows to the whole Ridge may be neceſſary, and they not little ones; and the Seaſon makes a Difference, as well as the Size of the Furrows, for when the Fine Mould is very dry (which is beſt) it will much of it run to the left Hand before the Plow, and alſo more will run back again to the left after the Plow is gone paſt it.

But when ſuch Ridges have been made for Wheat, and the Seaſon continues long too Dry for Planting it, and the Stubble not thrown up, we then Plow one Deep Furrow on the Middle of each Ridge, and then plow the whole Ridge at Four Furrows more, which will raiſe it very high. This way of Re-plowing the Ridges, moves all the Earth of them, and yet is done at Five Furrows.

The Furrows, neceſſary for raiſing up the Ridges, muſt be more or fewer, in regard to the Bigneſs of them; becauſe Six ſmall Furrows may be leſs than Four great ones. 'Tis not beſt to Plow the Stubble up to the Ridges, until juſt before Planting (eſpecially in the early plowing) becauſe that will hinder the Re-plowing of the firſt Furrows, which, if the Seaſon continues dry, may be neceſſary: Sometimes we do this by Opening one Furrow in the Middle of the Ridge, ſometimes two, and afterwards raiſe up the Ridges again; and when they are become moiſt enough at Top (the old Partitions being plow'd up to them) we harrow them once (and that only Length-ways) and then drill them.

There is a Neceſſity of plowing the old Partitions up to then ew Ridges, to ſupport their other Earth from falling down by the Harrowing and Drilling, which would elſe make them level.

Our Ridges, after the firſt time of plowing, excel common Ridges of the ſame Heighth; becauſe theſe tho' as deep in Mould at the Tops, have little of it Till'd at the laſt Plowing; but ours, being made upon the open Trenches, conſiſt of new till'd pulveriz'd Mould, from Top to Bottom.

'Tis a general Rule, That all ſorts of Grain and Seeds proſper beſt, ſown when the Ground is ſo dry, as to be broken into the moſt parts by the Plow. The Reaſon why Wheat is an Exception to that Rule is, becauſe it muſt endure the Rigours of Winter, which 'tis the better able to do, by the Earth's being preſs'd, or trodden harder and cloſer to it (1), as it is when moved wet.

If Wheat were as hardy as Rye, and its Roots as patient of Cold, it might, no doubt, be ſown in as dry a Seaſon as Rye is, and proſper the better for it, as Rye doth. This will appear, if Wheat and Rye be both ſown in the ſame dry Seaſon, after the Winter is over.

But as Wheat requires to have the Earth lie harder on, and about it, in the Winter; ſo it alſo requires more Dung (or ſomewhat elſe) to diſſolve the Earth about its Roots, after the cold Winter is paſt, than Rye doth, whoſe Roots never were ſo much confined.

'Tis another general Rule, that all ſorts of Vegetables

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(1) 'Tis for that Reaſon, that Farmers drive their Sheep over very light Land, as ſoon as 'tis ſown with Wheat, to tread the (Top or) Surface of it hard; and then the Cold of the Winter cannot ſo eaſily penetrate, to kill the Roots of the tender Plants.

tables thrive beſt, when ſown on freſh till'd Ground, immediately after 'tis plow'd.

Wheat is an Exception to this Rule alſo; for 'tis better to plow the Ground dry, and let it lie 'till the Weather moiſtens it (tho' it be ſeveral Weeks) and then Drill the Wheat: The Harrows and the Drill will move a ſufficient part of the Ground, which will ſtick together for Defence of the ſmall Roots, during the Winter, the reſt of the Mould lying open, and divided underneath until Spring, to Nouriſh them.

There is a ſort of binding Sand, that requires not only to be plow'd dry, but ſow'd dry alſo; or elſe the Wheat will dwindle in the Spring, and fail of being a tolerable Crop.

But what I mean by dry plowing, is not that the Land ſhould always be ſo void of Moiſture, as that the Duſt ſhould fly; but it muſt not be ſo wet, as to ſtick together (2). Neither ſhould we Drill when the Earth is wet as Pap, it ſuffices that it be moiſt, but moiſter in light Land, than in ſtrong Land, when we Drill.

If the two Furrows, whereon the Treble Row is to ſtand, be plow'd wet, the Earth of the Partitions may grow ſo hard by the Spring, that the Roots cannot run freely therein, unleſs there be Dung to ferment and keep it open.

So we ſee that a ſteep Bank, made of wet Earth, will lie faſt for ſeveral Years, when another made of the ſame Earth dry, will moulder, and run down very ſoon; becauſe its parts have not the Coheſion that holds the other together, it continues open and more porous, and crumbles continually down.

I have ſeen Trials of this Difference betwixt plowing Dry, and plowing Wet, for planting of Wheat, both in the Old way and in the Drilling way, but moſt in the latter; and never ſaw an Inſtance where the Dry plowing did not outdo the Wet; if the Wheat was not planted thereon before the Earth was become moiſt enough at Top.

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(2) But the drier 'tis plow'd the better.

And ſtrong Land plow'd wet in *November*, will be harder in the Spring, than if plow'd dry in *Auguſt*; tho' it would then have Three Months longer to lie.

After Rain, when the Top of the Ground is of a fit Moiſture for Drilling, Harrow it with two light Harrows, drawn by a Horſe going in the Furrow betwixt two Ridges; once will be enough, the Furrow being juſt broke to level, or rather ſmooth it for the Drill.

If the Veerings (1) whereon the next Crop is to ſtand, be plow'd Dry, we may Drill at any time during the common and uſual Wheat-Seed-Time, that is proper for the ſort of Wheat to be drill'd, and the ſort of Land, whether that be *early* or *late*, we may drill *earlier*, but not *later* than the ſowing Farmers. But I have had good Crops of Wheat drill'd at all times betwixt Harveſt and the Beginning of *November*.

For the Benefit of the middle Rows, 'tis better not to drill Wheat on ſtrong Land before the uſual Seaſon; becauſe the later 'tis planted, the more open the Partitions will be for the Roots of thoſe Rows to run thorough them in the Spring: and yet if the Earth of the Partitions be plow'd very wet, tho' late, they may be harder at the Spring, than thoſe which are plow'd early and dry.

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(1) The Word Veering is, I believe, taken from the Seamen, and ſignifies to Turn; it is the Plowman's Term for turning two Furrows toward each other, as they muſt do to begin a Ridge; and therefore they call the Top of a Ridge, a Veering; they call the two Furrows that are turn'd from each other at the Bottom, between two Ridges, a Henting, *i. e.* an Ending; becauſe it makes an End of plowing Ridges.

Our Intervals wholly conſiſt either of Veerings or Hentings; when two Furrows are turn'd from the Rows, they make a Veering; when turn'd towards the Rows, they are a Henting, which is the deep wide Trench in the Middle of an Interval.

There is a ſort of Wheat call'd by ſome *Smyrna Wheat*, it has a prodigious large Ear, with many leſſer (or collateral) Ears, coming all round the Bottom of this Ear; as it is the largeſt of all ſorts of Wheat, ſo it will diſpenſe with the Nouriſhment of a Garden, without being over-fed, and requires more Nouriſhment than the common Husbandry will afford it; for there its Ears grow not much bigger than thoſe of common Wheat; this I believe to be, for that Reaſon, the very beſt ſort for the Hoeing Husbandry; next to this I eſteem the White-Cone Wheat, then the Grey-Cone. I have had very good Crops from other ſorts, but look upon theſe to be the beſt.

When Wheat is planted early, leſs Seed is required, than when late; becauſe leſs of it will die in the Winter, than of that planted late, and it has more time to Tiller (1).

Poor Land ſhould have more Seed than rich Land, becauſe a leſs Number of the Plants will ſurvive the Winter on poor Land.

The leaſt quantity of Seed may ſuffice for rich Land that is planted early; for thereon very few Plants will die: and the Hoe will cauſe a ſmall Number of Plants to ſend out a vaſt Number of Stalks, which will have large Ears, and in theſe, more than in the Number of Plants, conſiſts the Goodneſs of a Crop (2).

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(1) To *Tiller* is to branch out into many Stalks, and is the Country Word that ſignifies the ſame with *Fruticare*.

(2) A too great Number of Plants do neither Tiller, nor produce ſo large Ears, nor make half ſo good a Crop, as a bare competent Number of Plants will.

Another thing muſt be conſider'd, in order to find the juſt Proportion of Seed to plant; and that is, that ſome Wheat has its Grains twice as big as other Wheat of the ſame ſort, and then a Buſhel (1) will contain but half the Number of Grains; and one Buſhel of ſmall-Grain'd Wheat will plant as much Ground as two Buſhels of the large-Grain'd; for in truth 'tis not the Meaſure of the Seed, but the Number of Grains, to which reſpect ought to be had in Apportioning the Quantity of it to the Land.

Some have thought, that a large Grain of Wheat would produce a larger Plant than a ſmall Grain, but I have full Experience to the contrary. The ſmall Grain indeed, ſends up its firſt ſingle Blade in Proportion to its own Bulk; but afterwards becomes as large a Plant, as the largeſt Grain can produce, *cæteris paribus*.

Six Gallons of middle-ſiz'd Seed we moſt commonly drill on a Acre; yet on rich Land planted early, Four Gallons may ſuffice; becauſe then the Wheat will have Roots at the Top of the Ground before Winter, and Tiller very much, without danger of the Worms, and other Accidents that late planted Wheat is liable to.

If it's Drill'd too thick, 'twill be in danger of Falling; if too thin, it may happen to Tiller ſo late in the Spring, that ſome of the Ears may be blighted, yet a little thicker or thinner does not matter.

As to the Depth, we may plant from Half an Inch to Three Inches Deep: If planted too Deep, there is more Danger of its being eaten off by Worms, betwixt the Grain and the Blade (2); for as that Thread is the Thread of Life during the Winter (if not planted early) ſo the longer the Thread is, the more danger will there be of the Worms (1).

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(1) One Buſhel contains Seventy Pound of the beſt Wheat.

(2) A Wheat Plant, that is not planted early, ſends out no Root above the Grain before the Spring; and is nouriſh'd all the Winter by a ſingle Thread, proceeding from the Grain up to the Surface of the Ground.

'Tis a neceſſary Caution to beware of the Rooks, juſt as the Wheat begins to peep; for before you can perceive it to be coming up, they will find it and dig it up to eat the Grain; therefore you muſt keep them off for a Week or Ten Days, and in that time the Blade will become Green, and the Grain ſo much exhauſted of its Flour, that the Rooks think it not worth while to dig after it.

But the Rooks do not moleſt Wheat that is planted before or a little after St. *Michael*; for then there remains Corn enough in the Fields, which is left at Harveſt above Ground, that Rooks prefer always before Corn which muſt coſt them the Labour of digging to find it.

Of Partitions *between Double, Treble, and Quadruple Rows.*

The double Row has but one Partition, and this is beſt to be uſed when the Land is ſuſpected to be full of the Seed of ſuch Weeds as muſt be taken out by the Hand-Hoe; in this Partition while they are young, thoſe which come up in the very Rows, may be pull'd out when they are grown to a proper Bigneſs.

This Partition I ſhould chooſe to have a Foot (2) wide, becauſe I have had whole Fields drill'd, all at that Diſtance, Hand-Hoed at the Expence of Four Shillings *per* Acre; and therefore when there is but one Foot in ſix, it ought to coſt but a proportionable Price *per* Acre.

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(1) Becauſe the Worms can more eaſily find a Thread, that extends by its Length to five or ſix Inches Depth, than one which reaches but one Inch: and beſides, the Worms in Winter do not inhabit very near the Surface of the Ground; and therefore alſo miſs the ſhort Threads, and meet with the long ones.

(2) But the Difference betwixt a Foot and Fourteen Inches

The common Width of the two Partitions of the treble Row is, either ſeven or eight Inches each. To find out the beſt Diſtance of planting theſe Rows, I made one of the Partitions ſix Inches, and the other nine Inches; and they being harrow'd by a common Harrow, whoſe Tines covering the Rows, ſometimes from one ſide, ſometimes from the other ſide, made thoſe Partitions yet more unequal; in theſe I obſerv'd all the Spring-time, that in moſt Places, that outſide Row which was neareſt to the middle Row, was leſs than the other outſide Row which was farther from it (1): And that, that leaſt outſide Row was only equal to the middle Row, the other much exceeding either of theſe, but yet there was not this Difference in all Places; becauſe perhaps, the Hoe-Plow did not in theſe Places go ſo near to that Row, on the ſide of the narrower Partition, as it did to the other outſide Row.

I have for ſome Years planted my treble Rows at ſeven Inches aſunder, and find them ſucceed better than in wider Partitions: I obſerve that the better the Land is, either by Nature or Culture, the leſs Difference there is between the middle Row, and the two outſide ones, both at ſeven Inch and eight Inch Partitions. The greateſt Difficulty is to determine the moſt proper Width of Partitions; for if they are too Narrow, then all the Rows

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is ſo little, that 'tis ſcarce worth while to ſet a Drill on purpoſe; but to plant theſe double Rows at the common Diſtance of Fourteen Inches, without altering the Drill. Or if the middle Row be planted, we can eaſily chop it out along with the Weeds in the Spring, if we find it neceſſary.

(1) This Obſervation was before I planted my Rows on high Ridges.

may ſuffer by Injuring one another, before the time wherein they are ſupply'd with freſh Nouriſhment from the Hoed Intervals; and if the Partitions are too Wide, the middle Row will ſuffer by the too great Diſtance there is for its Roots to paſs thorough, before they can enter the Intervals.

In a large poor Field, drill'd with Wheat in double Rows, the Partition not being confin'd, was unequal, and more unequal than is uſual, even when the Partition is the Parting (1) Space, as it was here. After this Wheat was taken off, I obſerv'd by the Strength of the Stubble, that in thoſe Places where the Partition happen'd to be but four or five Inches, the Stubble was as thick, and as ſtrong as where the the Partition was Eighteen Inches, or more; but where the Rows came nearer together than four or five Inches, ſo as to appear like one ſingle broad Row, the Stubble was ſmaller and weaker.

Hence it may be inferr'd, that where this Partition was wideſt, it gave no more Nouriſhment to the Two Rows (in Summer) than what was balanced by the greater Diſtance their Roots had to paſs, before they could reach thorough to the oppoſite Intervals; and the wider this Partition is, the fewer of the Roots will paſs through it; for the Roots going every way from a Plant, ſomewhat like the *Radii* of a Circle from its Center, each Row, to each Plant, in its oppoſite Row being as the *Chord of an Arch*, the farther 'tis from each oppoſite Plant, or Center, the fewer of the *Radii*, or Roots, will be interſected by that Row.

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(1) The Parting Space is that Diſtance which the Drill leaves betwixt the Row it plants in going one Way, and that Row which it makes in returning back; this Diſtance cannot be ſuppoſed to be ſo exactly equal in all Places, as thoſe Diſtances which are confin'd as being made betwixt the Shares of the Drill; for when the Drill has two Shares, the Space or Diſtance betwixt them cannot vary.

But as for the Rows that approach'd too near together, they were ſtunted at firſt, whilſt they were young; (and before they could have the Benefit of Hoeing) for the two Rows having then as it were, no Partition between them, could have but half the Nouriſhment they would have had, if the Partition had been wide enough to Half maintain them in their Infancy.

I have not as yet made a Drill on purpoſe for Quadruple Rows, but I make ſome of thoſe Rows every Year with my Treble Drill, in this manner, *viz.* I take off the Fore-Hopper, and the Drill plants fourteen Inches aſunder, and then the Horſe returning back, goes on one of theſe two Rows, and plants one more Row, betwixt the other two, and one on the Outſide, this makes a Quadruple Row; but then its Partitions are always uneven, which gives a much better Direction how wide to make the Partitions, than if they were even; for the farther theſe two middle Rows are from one another, the nearer they are to the outſide Rows, and the wider is the middle Partition; but the nearer the middle Rows are to one another, the farther they muſt be from the outſide Rows. In this laſt Caſe I obſerve, that the two middle Rows, when very near together, weigh leſs than the one middle Row on the Ridge of equal Height next adjoining; but in the other Caſe, when the middle Rows are nearer, *viz.* at the Diſtance of ſix Inches, from the Outſides, their Produce is much larger than one middle Row. Hence I conclude, that Quadruple Rows ſhould have ſix Inches Partitions, the Ridges rais'd high on good Ground well pulveriz'd, to keep the Plants from being ſtunted when young; and the Land ſhould be made pretty clean from Weeds.

Theſe Three Partitions being only eighteen Inches, will not occaſion a much greater Breadth of

Ridges than Treble Rows, which have only two Partitions.

Neither of the two middle Rows in a Quadruple Row, planted on the Level, is ſo good as the one middle Row in a Treble Row, the Partitions in both being ſeven Inches; and there can be no other Reaſon for that Difference, but that the one middle Row has only one Partition, and one Row to paſs through on each ſide of it, before its Roots reach into the Two Intervals; but each of the two middle Rows have Two Partitions, and Two Rows on one ſide to paſs, e'er they reach the Interval on that ſide; ſo that the ſingle middle Row has the Benefit of two Intervals, and each of the double middle Rows has only the Benefit of one Interval.

This Difference is alſo a Proof, that the middle Rows do receive Nouriſhment from the Intervals, for elſe the one middle Row, and each of the two would be all Equal.

If by the Shallowneſs of the Soil, the Narrowneſs of the Plow, or by any other Cauſe, the Furrows are too ſmall to raiſe the Ridges high enough at Once, you muſt raiſe them higher at Twice Plowing; or elſe expect that the middle Row will be the leſs, for want of more Paſture underneath it; becauſe it muſt have Narrow Partitions, that it may be the nearer to the Intervals, and therefore the Paſture that is wanting (in the Partitions on each ſide) cannot be ſupply'd but from below, until the Roots reach the Intervals.

The middle Row muſt not be too Numerous in Plants; for then they will be the weaker, and leſs able to ſend out their Roots into the Intervals, early in the Spring; and indeed if the outſide Rows are too thick in Plants, they will rob the middle Row the more when young; and afterwards their Roots will form the thicker Hedges, to obſtruct thoſe of the middle Row from paſſing ſo eaſily out of the Partitions. I remember that the Roots of my Row that I found had reach'd the Interval at Eighteen Inches Diſtance (which was then the full Height of the Plants) having firſt paſs'd through another Row in their way, both theſe Rows were Thin of Plants; planted late, the Land made very fine, being a Friable Soil, all which made ſome little amends for the want of Ridges; this Land being planted upon the Level.

But yet I always find that Ridges, by the Advantages they have above Land that is Level, do *(cæteris paribus)* bring the beſt Crop, and are more eaſily managed (1).

June 19, 1731. I could never until this Year, bring my middle Rows to be any thing near equal to the outſide Rows, but now I have done it, both in the Treble and Quadruple.

The Earth was all thrown out of the Middle of the Intervals before laſt Harveſt, being firſt well pulveriz'd; then ſome time after Harveſt, this Earth when dry, was raiſed up to a pretty high Ridge, in the middle of each Interval, from whence it was taken; and when the Weather had made it ſufficiently moiſt, the Wheat was Drill'd thereon, with ſeven Inch Partitions: This Wheat flouriſh'd all the Winter and

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(1) 'Tis no ſmall Advantage in this Management, that whether the Veering or the Henting be left in the Interval by the Hoe-plow, all the Furrows in a whole Field lie continually open; ſo that the Maſter cannot be cheated by his Plowmen, who might otherwiſe perſuade him they plow'd deep when they plow ſhallow. But in common plowing, all the Furrows may be ſhallow, except the laſt two of every Ridge, which has perhaps forty Furrows, thirty-eight of which lying always cover'd, 'tis not eaſy to know how deep they are plow'd: And of all the Villanies of *Engliſh* Plow-Servants, This Trick of plowing too ſhallow, has Undone the moſt Farmers.

Spring, and the middle Rows ſeem equal to the outſide Rows, by their Colour and Height, both in the Treble and Quadruple, all being much ſtronger than the adjoining ſown Crops, tho' on Dung'd Fallows Four Times Plow'd, and mine being without Dung for many Years paſt.

The deep pulveriz'd Mould keeps the Plants ſtrong in the Winter and Spring, which enables the middle Row to ſend out its Roots the more vigorouſly through the Roots of the outſide Rows; which Rows, if they were on ſhallow Mould, would bar in the Roots of the middle Row, becauſe the Roots are thickeſt near the Stems.

When the Plants of the middle Row are too numerous for the Paſture of the Partitions, for want of a ſufficient Depth of pulveriz'd Earth, they are weak and unable to ſend out their Roots vigorouſly enough, to reach the Intervals in time; alſo when the Plants of the outer Row are too numerous on a ſhallow Mould, the Roots of theſe, which are always thickeſt near the Bottom of the Stems, make a *Septum* or Hedge betwixt the Roots of the middle (or inner) Row and the Interval, this very much obſtructs their Paſſage; but when the pulveriz'd Mould is deep under the outſide Row, then the Roots of it are thinner below, and admit the Roots of the middle Row to paſs through among and between them there.

But if the Hoe-Plow does not at the firſt Hoeing go deep and near to the Rows, the ſubſided Earth will, eſpecially in ſtrong Land, be as a Wall to confine the Roots of all the Rows from entering the Interval in the Spring and Summer, which is the time they require moſt Nouriſhment from it.

Experience has ſhewn me this Year, that this is the Reaſon that the middle Row falls ſhort of, or equals the outſide Row; for in about ſixty Acres of Wheat I now have near ripe, there is not one Row whether Treble or Quadruple, wherein the middle Row (or Rows) do not ſucceed according as they are managed, by the one or the other Method, *viz.* where any middle (or inner) Row has a competent Number of Plants, ſtanding on a competent Thickneſs of ſufficiently well pulveris'd Earth, and its outſide Row the ſame whereunto the Hoe-Plow has went deep and very near, ſuch middle Row equals the outſide Row; but where ever any of theſe Circumſtances are wanting, the middle Row falls ſhort more or leſs in Proportion, as more or fewer of them are wanting. The middle Row having more Paſture underneath it, may ſtand the nearer to the outſide Rows, without being ſtunted in the Winter or Spring, and therefore may be as well and better Nouriſh'd by ſeven Inch Partitions, than by thoſe much wider and thinner, tho' equally pulveriz'd; and then being of equal Strength, will ſend out its Roots the ſooner into the Intervals, by how much it ſtands nearer to them. Beſides, I find that ſeven Inch Partitions may be Hand-Hoed early in the Spring, and the Rows being ſo near together, prevent the Weeds from thriving in the Partitions when they are not Hoed; and when Poppies do come in them, they always thruſt out their Heads into the Intervals for Air, and may be very eaſily pull'd out.

The Firſt Hoeing is perform'd by turning a Furrow from the Row.

We are not ſo exact as to the Weather in the Firſt Hoeing; for if the Earth be wet, the Hoe-Plow may go the nearer to the Row, without burying the Wheat; and the Froſt of the Winter will pulverize that Part of the Furrow, which is to be thrown to the Wheat in the Spring, although it was Hoed wet.

Neither is it neceſſary to be very exact as to Time, but it muſt never be 'till the Wheat has more than One Blade; and it may be ſoon enough, when it has four or five Leaves, ſo that it's done before, or in the Beginning of Winter.

The greateſt Fault you can commit in Hoeing, is the Firſt Time, when the Furrow is turn'd from the Row, not to go near enough to it, nor deep enough. You cannot then go too near it, unleſs you plow it out, and Bury it with Mould, and do not uncover it; nor too deep, unleſs you go below the Staple of the Ground.

Servants are apt to Hoe too far from the Rows, going backwards and forwards, in the middle of the Intervals, without coming near the Rows; this loſes moſt of the Benefit of Hoeing; and is very injurious to the preſent Crop, and alſo to the Two ſucceeding Crops; for then there will be a Deficiency of pulveriz'd Earth; and no Body can ſuppoſe, that the Hoed Earth can be of any Benefit to the Rows, before the Roots reach into it; and when 'tis far off, few of the Roots reach it at all, and thoſe that do reach, come there too late to bring the Plants to their full Perfection: Therefore if the Firſt Furrow was not Near enough, nor Deep enough, plow a ſecond Furrow at the Bottom of the former, which will go deeper than the firſt, and break the Earth more; beſides taking away from the Rows ſuch unmov'd Ground, which the Firſt plowing may poſſibly have miſs'd. If this can't be conveniently done ſoon after the Firſt Hoeing, do it before the Ridge is turn'd back in the Spring.

Always leave the Furrows turn'd up, to make Ridges (1) in the middle of the Intervals during

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(1) Tho' the Ridge in the middle of the Interval ſhould, for want of ſufficient Mould or otherwiſe, be too low to give Shel-

ing the Winter; and the hollow Furrows, or Trenches next the Rows, being enrich'd by the Froſt (1) and Rains (2), the Wheat will have the Benefit of them earlier in the Spring, than if the Trenches had been left open in the middle of the Intervals.

Shelter, yet there is generally ſome Earth falls to the left of the Hoe-plow, and lodges upon that part which is left on the Outſide of the Row; which, notwithſtanding that part be very narrow (as ſuppoſe two or three Inches) yet a ſmall Quantity of Earth lying thereon, ſo near to the Outſide Row, gives an extraordinary Shelter to the young Wheat Plants that grow in it.

Shelter is a great Benefit to Wheat, but yet Nouriſhment is more; for in the Winter I ſee the Wheat Plants upon the moſt expoſed part of the Ridge flouriſh, when ſingle Plants in the Bottom of the Furrow are in a very poor languiſhing Condition, without any Annoyance of Water, they being upon a Chalk Bottom.

(1) Froſt, if it does not kill the Wheat, is of great Benefit to it; Water or Moiſture when it is Frozen in the Earth, takes up more Room than in its natural State; this ſwelling of the Ice (which is Water congeal'd) muſt move and break the Earth wherewith it is mixt; and when it Thaws, the Earth is left hollow and open, which is a kind of Hoeing to it. This Benefit is done chiefly to, and near the Surface; conſequently the more Surface there is by the Unevenneſs of the Land, the more Advantage the Soil has from the Froſt.

This is another very great Uſe of the Ridge left in the Middle of the Interval during the Winter; becauſe that Ridge and its two Furrows contain four times as much Surface as when level. This thus pulveriz'd Surface turn'd in, in the Spring-Hoeing, enriches the Earth, in proportion to its Encreaſe of internal Superficies, and likewiſe proportionably nouriſhes the Plants, whoſe Roots enter it; and that part of it wherein they do not enter, muſt remain more enrich'd for the next Crop, than if the Soil had remained level all the Winter.

(2) It is a vulgar Error, that the Winter Rains do not Enrich the Earth, and is only thought ſo, becauſe we do not ſee the Effect of them upon Vegetables, for lack of Heat in that Seaſon. But ſome Farmers have frequently obſerved, that One Half of a Ground plow'd up juſt before Winter, has produc'd a Crop of Barley as much better than the Other Part plow'd up at the End of Winter, as is the Difference of a Dunging, even when there has been very little Froſt.

The Outſide Rows of Wheat, from which the Earth is Hoed off, before or in the Beginning of Winter, and left almoſt bare 'till the Spring, One would think ſhould ſuffer by the Froſt coming ſo near them (1) or for want of Paſture, but it appears to be quite contrary; for where the Hoe has gone neareſt to a Row, its Plants thrive beſt: The Earth, which the Froſt hath pulveriz'd, being within the Reach of the young ſhort Roots, on that ſide of the Row from the Top to the Bottom of the Trench, Nouriſhes them at firſt, and before the Plants have much exhauſted this, as they grow larger in the Spring, the Ridge from the middle of the Interval is thrown to them, having a perfectly unexhauſted Paſture, to ſupply their increaſing Bulk with more Nouriſhment.

The Row ſtanding as it were on the Brink of this almoſt perpendicular Ditch, the Water runs off quickly, or does not enter but a very little way into this ſteep Side; ſo that the Earth at the Plants being dry, the Froſt does not reach quite to all their Roots to hurt them, tho' the Diſtance from the Air to the Roots be very ſhort: And dry Earth doth not freeze as wet doth, neither is this Ditch much expoſed to the cold Winds.

The Spring-Hoeing is perform'd after the greateſt Froſts are paſt, and when the Weather will al-

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(4) In very light Land, perhaps we muſt not Hoe quite ſo near to the Rows of Wheat, as in ſtrong Land, for fear the Winter ſhould lay the Roots bare, and expoſe them too much to the Cold; but then we may be ſure that in this Caſe, the Roots will reach the Interval, at a greater Diſtance, than in ſtrong Land; yet ſuch very light Land is not proper for Wheat.

low it: And then turn (1) the Ridge from (2) the Middle of the Interval, to the Rows on each ſide, by Two Furrows as near as can be, without covering the Wheat; in doing which have Regard to the Row only, without looking at the Middle of the Interval; for 'tis no matter if a little Earth be left there, the next Hoeing or the next ſave One (3) will move it.

As to how many Times Wheat is to be Hoed in the Summer, after this Spring Operation, it depends upon the Circumſtances (4) and Condition of the Land (5) and Weather (6); but be the Seaſon as it will, never ſuffer the Weeds to grow high, nor let any unmov'd Earth lie in the Middle of the Intervals long enough to grow hard; neither plow deep near the Rows in the Summer, when the Plants are large (1), but as deep in the middle of the Intervals as the Staple will allow; turning the Earth towards the Wheat, eſpecially at the laſt Hoeing, ſo as to leave a deep wide Trench in the Middle of each Interval.

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(1) 'Tis an Arrant Miſtake of the Vulgar, when they imagine that the immediate Benefit of freſh Earth to Plants, is from that part which remains uppermoſt; for 'tis from turning the impregnated pulveriz'd ſide downwards, to be fed on by the Roots that gives the *Pabulum*, or Nouriſhment of the freſh Earth to Plants, the other ſide being turn'd upwards, becomes impregnate alſo in a little Time.

(2) But Note, that when we ſee Weeds coming up near the Row in the Spring, we plow again from the Rows (and ſometimes can plow within one Inch of the Row) before we turn down the Mould, from the Middle of the Interval.

(3) If at the next Hoeing we turn another Furrow towards the Row (which is ſeldom done) then 'tis the next that moves the remaining Earth, left in the Middle of the Interval: but if the next Hoeing be from the Row (as it generally is) then that covers the Middle of the Interval, and then 'tis the next Hoeing after that, that turns all the Earth clean out of the Middle of the Interval toward the Rows.

(4) If the Land was not ſufficiently Till'd or Ho'd in the precedent Year, it will require the more Hoeings in the following Year.

(5) the poorer the Land is, the more Hoeings ſhould it have.

(6) A wet Summer may prevent ſome of the Hoeings, that we ſhould perform in a dry Summer.

We Augment our Wheat-Crops Four ways; not in Number of Plants, but in Stalks, Ears, and Grains.

The Firſt is, by increaſing the Number of Stalks, from One, Two, or Three, to Thirty or Forty to a Plant, in ordinary Field Land.

And we Augment the Crop, by bringing up all the Stalks into Ears, which is the Second Way; for if it be diligently obſerv'd, we ſhall find that not Half (2) the Stalks of Sown Wheat come into Ear.

I ſaw an Experiment of this in Rows of Wheat that were equally poor, One of theſe Rows was encreaſed (3) ſo much, as to produce more Grains than Ten of the Other, by bringing up more of its Stalks into Ears, and alſo by augmenting its Ears to a much greater Bigneſs, which is the Third Way; for whatever *Varro* means by ſaying, that the Ears remain Fifteen Days in *Vaginis*, 'tis pretty plain that the Ears are form'd together with the Stalks, and will be very Large or very Small, in Proportion to the Nouriſhment given them.

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(1) Our Hoeing deep near the Plants when ſmall, breaks off only the Ends of the Roots; but after the Roots are ſpread far in the Interval, the greateſt part of them being then on the Right-hand ſide of the Hoe-Plow, might hold faſt on that ſide, and not be drawn out, and then the whole Roots would be broken off cloſe to the Bodies of the Plants; therefore at the Second deep Hoeing, that turns a Furrow from the Row in the Summer, we go about Four or Six Inches farther off from the Row than the Time before; but we go nearer or farther off, according to the Diſtance of Time between thoſe Two Hoeings: Yet we may Hoe *ſhallow* near to the Plants at any Time, without Injury to their Roots, but on the contrary, it will be Advantageous to them.

(2) If a ſquare Yard of ſown Wheat be mark'd out, and the Stalks thereon number'd in the Spring, it will be found, that Nine Parts in Ten are miſſing at Harveſt.

(3) Theſe Rows were Drill'd a Foot aſunder not Ho'd, and were by the Shallowneſs and Wetneſs of the Soil, very poor in the Spring; and then, by pouring Urine to the Bottom of this Row, it was ſo vaſtly encreaſed above the reſt.

The Laſt and Fourth Way of Augmenting the Produce of Wheat Plants, is by cauſing them to have Large and Plump Grains in the Ears; and this can no way be ſo effectually done, as by late Hoeing, eſpecially juſt after the Wheat is gone out of the Bloſſom, and when ſuch Ho'd Grains weigh double the Weight of the ſame Number of Unho'd, (which they frequently will) tho' the Number of Grains in the Ho'd are only equal, yet the Ho'd Crop muſt be double.

Thus by encreaſing the Number of Stalks (1), bringing more of them up into Ear (2), making the Ears larger (3), and the Grain plumper and fuller of Flower (1), the Hoeing Method makes a greater Crop from a Tenth (2) Part of the Plants, than the Sowing Method can.

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(1) The ſame Plant that when poor ſends out but Two or Tree Tillers, would if well nouriſh'd by the Hoe or otherwiſe, ſend up a Multitude of Tillers, as is ſeen in Ho'd Wheat and Sown Wheat.

(2) Mr. *Houghton* relates Eighty Ears on One ſingle Plant of Wheat, and a greater Number has been counted lately in a Garden; thoſe Eighty reckon'd to have fifty Grains a piece, make an Encreaſe of Four Thouſand Grains for One: but I have never found above Forty Ears from a ſingle Plant in my Fields; yet there is no doubt, but that every Plant would produce as many as Mr. *Houghton*'s of the ſame Sort, with the ſame Nouriſhment; But I ſhould not deſire any to be ſo prolifick in Stalks, leſt they ſhould fail of bringing ſuch a Multitude of Ears to Perfection. The Four Hundred Ears that I numbred in a Yard, were not weigh'd, becauſe they were told before ripe, and the greateſt Weight of Wheat that ever I had from a Yard, was the Product of about Two Hundred and Fifty Ears, and ſome of them were ſmall.

(3) I have number'd One Hundred and Nine Grains in One

All theſe Advantages will be loſt by thoſe Drillers, who do not overcome the unreaſonable Prejudices of the Unexperienc'd, concerning the Width of Intervals.

In wide Intervals, we can raiſe a good Crop with leſs Labour, leſs Seed, no Dung, no Fallow, but not without a competent Quantity of Earth, which is the leaſt Expenſive of any thing given to Corn: The Earth of a whole good Acre, being but about the Tenth Part of the common Expence; and of in-

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One Ear of my Hoed Cone-Wheat, of the Grey Sort: And One Ear of my Hoed Lammas-Wheat has been meaſured to be Eight Inches long, which is double to thoſe of Sown Wheat. I have ſome of theſe Ears now by me, almoſt as long, the longeſt being given away as a Rarity; and indeed 'tis not every Year that they grow to that Length, and 'tis always where the Plants are pretty ſingle. But there is no Year wherein One Ear of my Hoed does not more than weigh Two of the Sown Ears, taking a whole Sheaf of each together without Chooſing. The Sheaves of the Hoed are of a different Shape from the other; almoſt all the Ears of the Hoed are at the Top of the Sheaf; but moſt of the other are ſituate at the lower part, or near the middle of the Sheaf.

(1) Seed Cone-Wheat, coming all out of the ſame Heap, planted all at the ſame Time, and on Land of the ſame Sort adjoyning near together, the Wheat that was Sown produc'd Grains ſo ſmall, and that which was Drill'd ſo very large, that no Farmer or Wheat-Buyer would believe them to be of the ſame ſort of Wheat, except thoſe who knew it, which were many. One Grain of the Drill'd weighed Two of the Sown, and there was Twice the Chaff in an equal Weight of the Sown, being both weigh'd before and after the Weight was ſeparated from the Chaff.

(2) But tho' a too great Number of Plants be upon many Accounts very Injurious to the Crop, yet 'tis beſt to have a competent Number; which yet needs not be ſo exact, but that we may expect a great Crop from Twenty, Forty, or Fifty Plants in a Yard of the Treble Row, if well managed.

different Land, a Twentieth, and ſuch I count that of Five Shillings and Six Pence *per* Acre.

The Crop enjoys all the Earth, for between the laſt Hoeing and the Harveſt, there remains nothing but Space empty of Mould, in the Middle of the Intervals.

In our Five Foot (1) Intervals, 'tis not neceſſary that we keep the Roots from paſſing through all the Mould, (if the Wheat be of a proper Sort) for they will always leave a ſufficient Paſture for a ſucceeding Crop, becauſe 'tis impoſſible for them to come into Contact with it all in One Year; but the more Paſture is made by frequent Hoeing, the more will be left unexhauſted.

'Tis an Objection, that great Part of thoſe wide Intervals muſt be loſt, becauſe the Wheat Roots do not reach it; but as we generally turn the Mould towards the Row, at the laſt Hoeings, there is no Part of it above Two Foot diſtant from even the Middle Row, and Seventeen Inches from either of the Outſide Rows.

And I have plainly prov'd, that the Roots of Cone-Wheat have reach'd Mould at Two Foot Diſtance, after paſſing thorough another Row, at a Foot Diſtance from it, the Plants being then but Eighteen Inches high, and but half grown.

Farmers do not grudge to beſtow Three or Four Pound in the Buying and Carriage of Dung for an Acre; but think themſelves Undone, if they afford an extraordinary Eighteen Pennyworth of Earth to the wide Intervals of an Acre; not conſidering that Earth is not only the Beſt, but alſo the Cheapeſt Entertainment that can be given to Plants: For at Five Shillings and Six Pence Rent, the whole Earth belonging to each of our Rows coſts only Six Pence, *i. e.* a Penny for a Foot broad, and Six Hundred and Sixty Foot long, that being the Sixty-ſixth part of an Acre (1).

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(1) We call them Five Foot Intervals, tho' they are but Four Foot Ten Inches Broad; theſe being the Wideſt that we find are proper for Wheat; but it is not to be imagined, that we can be ſo exact, to make our Ridges or Intervals to an Inch; Yet we make the Ridges as exact as we can with the Plow, and the Intervals as even as we can, by guiding the Drill exactly on the middle of the Top of each Ridge.

And if for conſtant Annual Wheat Crops, you make Fewer than Eleven Rows on Four Perch Breadth, you will always encreaſe the Expence of Hoeing; becauſe then Two Furrows will not Hoe One of thoſe Intervals, and you will alſo thereby leſſen the Crops, but improve the Land more. And if you encreaſe that Number of Rows, you will thereby encreaſe every Expence; for there muſt be Two Furrows to Hoe a Narrow Interval, and an Encreaſe of the Quantity of Seed, and the Labour in Uncovering, Weeding and Reaping, and alſo you will leſs improve the Land, and leſſen the Crops after the firſt Year.

If the Intervals are Narrower in Deep Land, tho' there might be Mould enough in them, yet there would not be Room to pulverize it.

If Narrower in Shallow Land, tho' there were Room, yet there would not be Mould enough in them to be pulveriz'd.

The Horſe-Hoe well apply'd, doth ſupply the Uſe of Dung and Fallow; but it cannot ſupply the Uſe of Earth, tho' it can infinitely encreaſe the Vegetable Paſture of it, by pulverizing it, where it is in a reaſonable Quantity; yet if the Intervals be ſo Narrow, that near all the Earth of them goes to make the Partitions raiſed at Top of the Ridges, there will be ſo little to be pulveriz'd, that you muſt return to Fallowing, and to the Dung-Cart, and to all the Old exorbitant Charges (1).

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(1) But the Vulgar compute this Expence of a Foot Breadth of Ground, not only as of the Rent, as they ought, but as an Eleventh Part of their own uſual Charges added to the Rent.

And there is Land enough in *England*, to be had at the Rent of Five Shillings and Six Pence the Acre, that is very proper for Wheat in the Hoeing Huſbandry.

Eight Acres, Part of a Ground of Twenty Acres, Drill'd with Intervals of Three Foot and a Half, brought a good Crop; but the Second Year, not being Hoed, the Crop was poor; and the Third Crop made that Land ſo Foul and Turfſy, that 'twas forc'd to lie for a Fallow, there being no way to bring it into Tilth, without a Summer-plowing (2), when the reſt of the ſame Piece, in wider Intervals, being conſtantly Hoed, continued in good Tilth, and never fail'd to yield a good Crop, without miſſing one Year.

In another Field, there is now a Sixth Crop of Wheat, in wide Intervals, very promiſing, tho' this Ground has had no ſort of Dung to any of theſe Crops, or in ſeveral Years before them: The laſt Year's Crop was the Fifth, and was the beſt of the Five, tho' a Yard of the Row yielded but Eighteen Ounces and Three Quarters, and the Third Crop yielded Twenty Ounces Weight (3) of clean

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(1) The Objections againſt theſe wide Intervals, are only for ſaving a Pennyworth or two of Earth in each Row, or a few Groats worth of it in an Acre; by ſaving of which Earth, they may loſe in the preſent and ſucceeding Crops, more Pounds.

(2) This Narrowneſs of the Intervals, if the Damage of it be rightly computed, wou'd amount to Half the Inheritance of the Land; and was occaſioned by the Wilfulneſs of my Bailiff, who Drilling it upon the Level, ordered the Horſe to be guided Half a Yard within the Mark, becauſe he fancy'd the Intervals would be too wide, if he follow'd my Directions.

(3) Wheat before Harveſt, ſtanding in Rows with wide Intervals

Wheat in the ſame Spot; but 'twas becauſe the Spot, where the Twenty grew, was then a little Higher than the reſt, which in two Years became more equal, and the Thin Land was more deficient in that Third Crop, than the Thick Land exceeded the Thin in the Fifth Crop.

In the Thick the Hoe-plow went Deeper, and conſequently raiſed more Paſture there; but then it went the Shallower in the Thin, and when the Land became of a more equal Depth the Fifth Year, the Plow and Hoe-Plow went deeper: All the Piece being taken together; for the Crop could be but in proportion to the different Paſture, allowing ſomewhat for the more or leſs Seaſonableneſs of the Year.

If it ſhould be demanded, from whence the Soil can be ſupply'd with Vegetable Matter, to anſwer what is carry'd off by theſe conſtant Crops of Wheat, that the Land be not conſumed by them, Mr. *Bradley* and his Correſpondent would give a very ready Anſwer, by ſaying, that Vegetables are Nouriſh'd by Air; and that the Earth ſerves for little elſe,

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tervals betwixt them, may not ſeem to the Eye to equal a Crop of half the Bigneſs diſpers'd all over the Land, when ſown in the common Manner; and yet there is more Deceit in the Appearance of thoſe different Crops, whilſt they are Young, and in Graſs; we ſhould therefore not Judge of them then by our Imagination, but as we do of the Sun and Moon nigh the Horizon, *viz.* by our Reaſon.

Imagination often deceives us, by Arguments Falſe, or Precarious; but Reaſon leads us to Demonſtration, by Weights and Meaſures. Yet this Prejudice will Vaniſh at Harveſt before weighing; for then all thoſe wide Intervals that were bare, will be cover'd with large Ears interfering to hide them quite, and make a finer Appearance than a ſown Crop. But 'tis obſerv'd, that the Cone-Wheat makes the fineſt Shew when you look on it Length-ways of the Rows, both at Harveſt, and a conſiderable Time before Harveſt.

than to keep them fix'd and ſteady; therefore the Wheat receiving its Augment from the Air, could not conſume any part of the Earth: This would be an eaſy good Solution, were it poſſible to be True.

The Soil in this our Caſe cannot be ſupply'd in Subſtance, but from the Atmoſphere. The Earth which the Rain brings can do it alone, if it fall in great Quantity; for by Water 'tis plain, the Earth which nouriſh'd *Helmont*'s Tree was ſupply'd; for the Tin Cover of the Box wherein it ſtood, prevented the Dews from entering.

Dews muſt add very much to the Land, thus continually Till'd and Hoed; for they are more heavily charged with Terreſtrial Matter, than Rain is, which appears from their forcing a Deſcent through the Air, when 'tis ſtrong enough to buoy up the Clouds from falling into Rain: And Dew, when kept in a Veſſel long enough to putrify, leaves a greater Quantity of Black Matter at the Bottom of the Veſſel, than Rain-Water does in a Veſſel of the ſame Bigneſs, fill'd with it 'till putrify'd.

Dews at Land, I ſuppoſe are firſt exhal'd from Rivers and moiſt Lands, and from the Expirations of Vegetables; moſt of the Dew that falls on it is re-exhal'd from untill'd Land; but moſt of that which falls on well Till'd or well Hoed Land, remains therein unexhal'd; ſo that the Untill'd Ground helps by that Means, to Enrich and Augment the Till'd, contrary to that of *Virgil: Nec nulla interea eſt Inaratæ gratia Terræ:* For if an Acre be Till'd Two Years together without Sowing, it will become richer by that Tillage, than by lying unplow'd Four Years, which may be eaſily prov'd by Experience (1).

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(1) *Non igitur Fatigatione, quemadmodum plurimi crediderunt,* Nec Senio, *ſed noſtra ſcilicet* Inertia *minus benigne nobis arva Reſpondent. Col.* Lib. II. Cap. I.

But then as to Rain, the Sea being larger than all the Land (and its Waters by their Motion becoming replete with Terreſtrial Matter) 'tis not unlikely that more Vapour is rais'd from One Acre of Sea, than from One Hundred Acres of Land. Hence 'tis very probable, that Iſlands are continually Gaining from the Deep, by means of Rain, which that Vapour (breaking againſt Mountains) produces.

Some have been ſo curious as to Compute the Quantity of Rain, that falls Yearly in ſome Places in *England*, by a Contrivance of a Veſſel to receive it; and 'tis found in One of the Drieſt Places, far from the Sea, to be Fourteen Inches deep, in the Compaſs of a Year; in ſome Places much more, *viz.* At *Paris* Nineteen Inches; in *Lancaſhire* Mr. *Townley* found, by a long continued Series of Obſervations, that there falls above Forty Inches of Water in a Year's Time.

Could we as eaſily Compute the true Quantity of Earth in Rain-Water, as the Quantity of Water is Computed, we might perhaps find it to anſwer the Quantity of Earth taken off from our Hoed Soil annually by the Wheat.

But if Land ſown with Wheat be not Ho'd, its Surface is ſoon Incruſtate, and then much of this Water, with its Contents runs off, and returns to the Sea, without entering that Ground; and in Summer, a great deal of what remains is exhal'd by the Sun, and rais'd by the Wind, both in Summer and Winter.

Some there are who think it a fatal Objection, that the more an Interval is Hoed, the more Weeds will grow in it; and that the Hoe can produce, or (as they ſay) breed in it as many Weeds in One Summer, as would have come thereon in Ten Years by the Old Husbandry. But by this Objection they only maintain, that the Hoe can deſtroy as many

Weeds in One Summer, as the Old Husbandry can in Ten Years.

And they might add, that ſince all Weeds that grow where the Hoe comes, are kill'd before they ſeed, and that few of thoſe which grow in the Old Husbandry, are kill'd (1) before their Seed be ripe and ſhed; theſe Objectors will be forc'd to allow, that Our Husbandry will leſſen a Stock of Weeds more in One Summer, than theirs can do to the World's End; unleſs they believe the Equivocal Generation of Weeds, than which Opinion nothing can be more Abſurd.

Some object againſt my Method of weighing a Yard, or a Perch in Length of a Row, ſaying, this does not determine the Produce of a whole Field.

I anſwer, that they judge right, if the Produce of the whole Field be not of equal Goodneſs; but if it be not, it muſt be becauſe one part of the Field is richer, or differently manag'd from the other part: For the ſame Cauſes that produce Twenty Ounces of clean Wheat upon one Yard, muſt produce the ſame Quantity upon every Yard of a Million of Acres.

When the Crop of half a Field is ſpoil'd by Sheep, not Hoed at all, or improperly, it would be ridiculous to Compute the whole Field together for an Experiment. We might indeed weigh the pooreſt, to prove the Difference of the one from the other, to try (as they ſometimes ſeem to do) how poor a Crop we can raiſe; but my Deſign was to try how good a Crop I could raiſe with a Tenth part of the common Expence.

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(1) Weeds cannot be kill'd before they grow, but will lie Dormant, as they do in our Partitions, and in their Sown Land; and while the Seeds are in the Ground, they are always ready to grow at the firſt Opportunity; and will certainly break out at one Time or other; ſo that preventing their coming, is only like Healing up a Wound before it be cured.

And I have often weighed the Produce of the ſame Quantity of Ground (1) of all ſorts of ſown Wheat, both the beſt and the worſt, but never have found any of the Sown equal to the beſt of my Drill'd; indeed we have none of the richeſt Land (2) in our Country within my reach, that being not above One Mile.

As a Yard in Length of my Treble Row of the Third ſucceſſive Crop of Wheat, without Dung or Fallow, produced Twenty Ounces of Wheat; which allowing ſix Foot to the Ridge, is about ſix Quarters to an Acre (3); and allowing ſeven Inches to each Partition, and two Inches on each Outſide, is in all Eighteen Inches of Ground on each treble Row, and but juſt one Fourth part of the Ridge. Now if in the Old Husbandry, the Crop was as good all over the Ground, as it was in theſe Eighteen Inches of the treble Row, they muſt have Twenty-four Quarters to an Acre; but let them dung whilſt they can, they will ſcarce raiſe Twenty-four Gallons of Wheat the Third Year, on an Acre of Land of equal Goodneſs; and let them leave out their Dung, and add no more Tillage in lieu of it, and I believe they will not expect Three Quarters to an Acre, in all the Three Years put together.

The mean Price of Wheat, betwixt Dear and Cheap, is reckon'd Five Shillings a Buſhel (4); and therefore an Acre that would produce every Year without any Expence, Eight Buſhels, would be thought an extraordinary Profitable Acre; but yet a Drill'd Acre, that produces Sixteen Buſhels of Wheat, with the Expence of Ten or Fifteen Shillings, is above a Third part more Profitable.

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(1) I allow Two Square Yards of their Crops to one Yard in Length of my Treble Row.

(2) I am ſorry that this Farm, whereon I have only practis'd Horſe-Hoeing, being ſituate upon a Hill that conſiſts of Chalk on one ſide, and Heath-Ground on the other, has been uſually noted for the pooreſt and ſhalloweſt Soil in the Neighbourhood

(3) Eight Buſhels make a Quarter.

(4) 'Tis commonly ſaid, that a Farmer cannot thrive, who for want of Money is oblig'd to ſell his Wheat under Five Shillings a Bu-

I don't know that I ever had an Acre yet, that was tolerably well manag'd in this Manner, but what produc'd much more.

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a Buſhel; but if he will ſell it Dear, he muſt keep it when 'tis Cheap: And his way of keeping it is in the Straw, uſing his beſt Contrivances to preſerve it from the Mice.

The moſt ſecure way of keeping a Great Quantity of Wheat, that ever I heard of, is by drying it. When I liv'd in *Oxfordſhire*, One of my neareſt Neighbours was very expert in this, having practis'd it for great part of his Life: When Wheat was under Three Shillings a Buſhel, he bought in the Markets as much of the middle ſort of Wheat as his Money would reach to purchaſe. He has often told me, that his Method was to dry it upon a Hair-Cloth in a Malt-Kiln, with no other Fuel than clean Wheat-Straw, never ſuffering it to have any ſtronger Heat than that of the Sun. The longeſt Time he ever let it remain in this Heat was Twelve Hours, and the ſhorteſt Time about Four Hours, the damper the Wheat was, and the longer intended to be kept, the more drying it requires; but how to diſtinguiſh nicely the Degrees of Dampneſs, and the Number of Hours proper for its Continuance upon the Kiln, he ſaid was an Art impoſſible to be learnt by any other Means than by Practice. About Three or Four and Twenty Years ago, Wheat being at Twelve Shillings a Buſhel, he had in his Granaries, as I was informed, Five Thouſand Quarters of dry'd Wheat, None of which coſt him above Three Shilling a Buſhel.

This dry'd Wheat was Eſteemed by the *London* Bakers, to work better than any new Wheat that the Markets afforded. His Speculation which put him upon this Project was, that 'twas only the ſuperfluous Moiſture of the Grain that caus'd its Corruption, and made it liable to be eaten by the Wevil; and that when this Moiſture was dry'd out, it might be kept ſweet and good for many Years; and that the Effect of all Heat of the ſame Degree was the ſame, whether of the Straw or of the Sun.

As a Proof, he would ſhew that every Grain of his Wheat would grow after being kept Seven Years.

He was a moſt ſincere honeſt Yeoman, who from a ſmall Subſtance he began with, left behind him about Forty Thouſand Pound, the greateſt part whereof was acquired by this Drying Method.

Chap. XII. *Of SMUTTINESS.*

SMUTTINESS is when the Grains of Wheat inſtead of Flour are full of a black ſtinking Powder; 'tis a Diſeaſe of Wheat, which I don't know is uſual any where but in cold *Northern* Countries; for if it had been common in *Greece* or *Italy*, there would probably have been ſome Word to expreſs it by, in thoſe Languages, as well as there is for the *Blight*.

I take it to be cauſed by cold wet Summers, and I was confirm'd in this, by ſeveral Plants of Wheat, taken up when they were in Graſs in the Spring, and plac'd in Troughs in my Chamber Window, with ſome of the Roots in Water, in exactly the ſame manner as the *Mints*, mark'd *H*, *H*, in Chapter of *Roots*: Theſe Wheat Plants ſent up ſeveral Ears each; but at Harveſt, every Grain was Smutty; and I obſerv'd, none of the Ears ever ſent out any Bloſſom; this Smuttineſs could not be from any Moiſture that deſcended upon it, but from the Earth, which always kept very moiſt, as in the aforeſaid Mint Experiment. The Wheat Plants in the Field, from whence theſe were taken, brought very few ſmutty Grains, but brought much larger Ears than theſe.

Whatſoever the Cauſe (1) be, there are but Two

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(1) The largeſt Grain'd, plump, fat Wheat, is more liable to Smuttineſs than ſmall Grain'd thin Wheat.

Remedies propoſed; and thoſe are *Brining*, and *Change of Seed.*

Brining of Wheat, to Cure or Prevent Smuttineſs (as I have been credibly inform'd) was accidentally diſcover'd about Seventy Years ago, in the following manner, *viz.* A Ship-Load of Wheat was ſunk near *Briſtol* in Autumn, and afterwards at Ebbs all taken up, after it had been ſoak'd in Sea-Water; but it being unfit for making of Bread, a Farmer ſow'd ſome of it in a Field, and when it was found to grow very well, the whole Cargo was bought at a low Price by many Farmers, and all of it ſown in different Places. At the following Harveſt, all the Wheat in *England* happen'd to be Smutty, except the Produce of this Brined Seed, and that was all clean from Smuttineſs. This Accident has been ſufficient to juſtify the Practice of Brining ever ſince in all the adjacent Parts, and in moſt Places in *England.*

I knew Two Farmers, whoſe Farms lay intermix'd; they bought the ſame Seed together, from a very good Change of Land, and parted every Load betwixt them in the Field. The Oldeſt Farmer believ'd Brining to be but a Fancy, and ſow'd his Seed Unbrined; the other Brined all his Part of Seed, and had not a Smutty Ear in his Crop; but the Old Farmer's Crop was very Smutty.

Wheat for Drilling muſt have no other Brine, than what is made of pure Salt; for if there be any Brine of Meat amongſt it, the Greaſe will not ſuffer the Wheat to be dry enough to be Drill'd.

If Seed-Wheat be ſoaked in Urine, it will not grow; or if only ſprinkled with it, it will moſt of it die, unleſs Planted preſently.

The moſt expeditious way of Brining Wheat for the Drill, is, to make a very ſtrong Brine; and when the Wheat is laid on a Heap, ſprinkle or lave it therewith; then turn it with a Shovel, and lave on more Brine: Turn it again with a Shovel, until by many Repetitions of this, the Wheat be all equally wet. Next ſift on Quick-Lime through a Sieve, turn the Wheat with a Shovel, and ſift on more Lime, repeat this ſifting and turning many times, which will make it dry enough to be Drill'd immediately; and this has been found ſufficient to preſerve uninfected Wheat from the Smut in a bad Year, the Seed being Chang'd.

To dry it, we uſe Quick-Lime (that is unſlack'd) which beaten to Powder and ſifted thereon, confines the Brine to the Surfaces of the Grains, and ſuffers none of it to be exhaled by the Air: But when Lime has been long ſlack'd, and is grown weak, 'tis unfit for this Purpoſe.

Smutty Seed-Wheat tho' Brined, will produce a ſmutty Crop, unleſs the Year prove very *favourable.*

For 'tis to be known, that favourable Years will cure the Smut, as *unkind* ones will cauſe it: Elſe before Brining was uſed, and the bad Years had cauſed all the Wheat in *England* to be ſmutty, they muſt have brought their Seed from foreign Countries, or never have had any clean Wheat; therefore 'tis certain, that kind Years will Cure the Smut: 'Tis therefore to prevent the Injury of a bad Year, that we plant clean Seed and well Brined.

But of the Two Remedies againſt Smuttineſs, a proper Change of Seed, ſome think the moſt certain.

A very worthy Gentleman aſſures me, that ſince he has found out a Place that affords a Change of Seed proper to his Land, which is for theſe Ten Years paſt, he never had a ſmutty Ear in any of his Crops (and he never Brines nor Limes it) tho' all other Wheat have been often ſmutty throughout his Neighbourhood every wet Year, tho' Brined and

Limed; he ſays the Perſon who furniſhes him with this Seed, is very curious in Changing his Seed alſo every Year.

This gives a Suſpicion, that our drowned Wheat at *Briſtol* might poſſibly be Foreign, and then might not have been ſmutty the next Year, tho' it had not been ſoak'd in the Sea-Water.

The Wheat ſown by the Two Farmers aforementioned might be from a good Change of Land, but the Seed not Changed the precedent Year; and then it might be no more infected, than what the Brine and Lime did cure.

To know what Changes are beſt to prevent Smuttineſs of Wheat, we muſt conſult the moſt Experienc'd; and they tell us, that the ſtrong Clay Land is beſt to be ſent to for Seed Wheat, whatever ſort of Land it be to be ſow'd upon; a White Clay is a good Change for a Red Clay, and a Red for a White. That from any Strong Land is better than from a Light Land, and the old Rhyme is, that *Sand* is a Change for no *Land*. But from whatever Land the Seed be taken, if it was not Changed the preceding Year, it may poſſibly be Infected, and then there may be Danger, tho' we have it immediately from never ſo proper a Soil.

The ſtrongeſt Objection that has been yet made againſt conſtant annual Crops of Wheat is, that thoſe Grains of the precedent Crop which happen to ſhed, and grow in the following Crop, will be in danger of Smuttineſs for want of changing thoſe individual Seeds.

All I can ſay in Anſwer is, that during theſe five Years, which is all the Time I have had theſe annual Crops, this objected Inconvenience never has happen'd to me, even when a precedent Crop has been ſmutty.

The Reaſon I take to be, that a Crop very early planted is not ſo apt to be ſmutty; and if it be not planted early, the Grains that are ſhed grow, and are kill'd before, or at the Time of planting the next Crop. This ſaves a Crop following a ſmutty one (which is always occaſion'd by bad Seed, or bad Ordering) and when the former Crop was planted with good Seed well order'd, the ſhatter'd Grains of that may produce clean Wheat the Second Year; and 'tis very unlikely, that any Breed of theſe Grains ſhould remain to grow in the Crop the Third Year.

Chap. XIII. *Of BLIGHT.*

THE Ancients did not take notice, that there were ſeveral Sorts of the Blight; neither did they enquire after their Cauſes, which unleſs they knew, it was not likely they ſhould find any effectual Remedy to prevent. They call'd it in general by the Name of *Rubigo*, for the Likeneſs the blighted Straws and Leaves had to ruſty Iron in Colour.

They thought it came all from Heaven, ſince they were ignorant of the natural Cauſes, *viz.* want of Nouriſhment in the Earth, *&c.*

Virgil was very ſincere, where he had no Hopes of any great Gain by Flattery; and tells the Huſbandman in plain Terms, that if his Corn be eaten with the Blight, he can give him no better Advice, than to comfort his Hunger by eating of Acorns; but has no Recipe to preſcribe by way of Prevention.

Palladius, *Lib.* 1. *Tit.* 35. recites many Receipts againſt the Blight, and other Injuries, which were thought to come from Above. The chief Efficacy of them ſeems to conſiſt in ſecret Contrivances, by Sympathies and Antipathies to fright the Clouds. And when Prayers and Sacrifices would not prevail with the *Cælicolæ*, the Ancients, it ſeems, proceeded to Threatnings. *Cruentæ ſecures contra cœlum minaciter levantur.* They brandiſh'd bloody Axes againſt the Gods, as a Summons to ſurrender, or elſe to expect no Quarter. But unleſs theſe Peaſants had been better Engineers than the Giants, in Beſieging Heaven, their Menaces muſt be vain. They acted like ſome modern Zealots, who take much the ſame Courſe with their Saints, as theſe Heathens did with their Gods: *viz.* When they are weary of praying in vain to their Images, that are ſo Idle or Obſtinate, as not to procure what their Votaries have a mind to, they think to bring them into better Manners by Correction; and from Prayers fall to Whipping their Saints in Effigie. Yet 'tis to be fear'd, none of this Bigottry will cure the Blight.

Palladius thought alſo, with others of the Ancients, that Heaven was to be frighted with Red-Cloth, with the Feathers or Hart of an Owl, and a multitude of ſuch ridiculous Scare-Crows, from ſpoiling the Fruits of the Fields and Gardens.

The Ancients having no rational Principles or Theory of *Agriculture*, plac'd their chief Confidence in Magical Charms and Enchantments; which he, who has the Curioſity and Patience to read, may find in the Title aforemention'd, in *Cato*, in *Varro*, (and even *Columella* is as fulſome as any of them) all written in very fine Language; which is moſt, if not all the Erudition, that can be acquir'd from the Greek and Latin Writers of Field-Husbandry in Verſe and in Proſe.

Wheat is Blighted at Two Seaſons; Firſt, when in the Bloſſom, and then its Generation is prevented, ed, and many of the Husks are empty in the Ear, the Grains not being impregnated.

Secondly, Wheat is Blighted when the Grains are brought to the time of their Maturity, but are light and of little Value for making of Bread; becauſe they are not well fill'd with Flour.

The Firſt cannot happen in *England* by the Froſt, becauſe the Winters do not ſuffer it to grow ſo much, as to come into Bloſſom before the Month of *June*; but it is long continual Rains that Rot or Chill the Bloſſoms, and prevent their Fertility. Yet this is what ſeldom happens to any great Degree, and we are happy that it does not, ſince modern Credulity is not ſtrong enough to rely on the Remedies preſcribed by the Ancients; and we know of no other which are effectual againſt this ſort of Blight. Wheat that grows in open Fields has ſome Advantage from the Wind, that diſlodges the Water ſooner from the Ears, than it can do in ſheltry Places; and Lammas-Wheat does not hold the Drops of Rain ſo long as the Bearded (or Cone) Wheat, which receiv'd very great Damage by this ſort of Blight in the Year 1725; the like never having been heard of before, I hope it may never happen again.

The Second Sort of Blight, *viz.* from light Ears, is, that which is moſt frequent and more general: This brings the greateſt Scarcity of Wheat. The Cauſe is plainly want of Nouriſhment to perfect the Grain, by whatever Means that Want is occaſion'd.

Several Accidents kill the Plants, or injure their Health, and then the Grains are not fill'd; as Lightning, the Effects whereof may be obſerv'd by the blackiſh Spots and Patches in Fields of Wheat, eſpecially in ſuch Years, as have more of it than uſual. Againſt this there is no Defence; for the Ancients tell you the Giants found that even Mountains were not Thunder-Proof.

And yet *Columella, Lib. x. Pag.* 353. ſays,

'*Utque Jovis magni prohiberet fulmina Tarchon,*
'*Sæpe ſuas Sedes percinxit vitibus albis.*

Ibid.

——————————*Salutis*
'*Ipſa novas artes varia experientia rerum,*
'*Et Labor oſtendit miſeris, uſuſque magiſter*
'*Tradidit agricolis, ventos ſedare furentes,*
'*Et Tempeſtatem Thuſcis advertere ſacris.*
'*Hinc mala Rubigo virideis ne torreat Herbas,*
'*Sanguine lactentis catuli placatur, & extis.*

What Credit can be given to the fine Words of theſe Ancients, who join all together in Verſe and in Proſe to impoſe upon Poſterity, even in Matters of Fact; and, by the moſt elegant Expreſſions, compoſe a Theory of Agriculture without Reaſon or Truth? They were moſt accompliſh'd Maſters of the Art of Cheating themſelves and us with Sound inſtead of Sence.

The other Cauſes of the Blight which are moſt general, and do the moſt Damage, may in ſome meaſure be prevented.

One Cauſe is the lodging or falling of Corn, for then the Stalks are broken near the Ground, whereby many of the Veſſels are ſo preſs'd, that the Juices cannot paſs them, and then the free Circulation is hinder'd, the Chyle cannot mount in ſufficient Quantity to be purify'd and turn'd into Sap; the Defect whereof makes the Plants become languid, and only juſt able to live; they have Strength enough to linger on to the time of their Period, as in very Old Age, but not to bring their Fruit, which is the Grain, to its natural Bulk, nor to fill it with Flour; and the ſooner the Stalks fall, the leſs and thinner the Grain will be.

Hence it often happens, that when Tillage, Dung, and good Land have brought a Crop of Wheat, that in the Months of *April* and *May* promiſe to yield the Owner Five or Six Quarters on an Acre, then in *June* it falls down, and ſcarce affords Five or Six Buſhels; and that perhaps is ſo thin and lank, that the Expence of Reaping and Thraſhing it, may over-balance its Value.

That the falling down of Wheat does cauſe the Ruin of the Crop, is well known; but what cauſes it to fall is not ſo plain.

And without knowing the true Cauſes, 'tis not likely that a Remedy ſhould be found againſt the Diſeaſe.

I take this Weakneſs of the Stalks, which occaſions their falling, to proceed from want of Nouriſhment, want of Air, want of the Sun's Rays, or of all Three.

One Argument, that it lodges for want of Nouriſhment is, that a rich Acre has maintain'd a Crop of Five Quarters ſtanding, when another poorer Acre was not able to ſupport a Crop from falling, which was but large enough to have brought Three Quarters, if it had ſtood; and this in the ſame Year, and on the ſame Situation. And 'tis very plain that if one Acre was twice as rich as the other, it muſt be able to nouriſh Five Quarters better than the other could nouriſh Three Quarters.

Air is neceſſary to the Life and Health of all Plants, tho' in very different Degrees: Aquaticks, which live under Water, are content with as little Air as their Companions, the Fiſhes.

But Wheat, being a Terreſtrial Plant (tho' in Winter it will live many Days under Water, whilſt the ſlow Motion of its Sap gives it little or no Encreaſe) requires a free open Air, and does not ſucceed ſo well in low ſheltery Places, as upon higher and opener Situations; where the Air has a greater Motion, and can more eaſily carry off the Recrements from the Leaves, after it has ſhaken off the Dews and Rains, which would otherwiſe ſuffocate the Plants; and therefore the Leaves are made ſo ſuſceptible of Motion from the Air, which frees them from the Dews, that would ſtop in the Recrements at the *Veſiculæ* of the Leaves, but ſhaken down will nouriſh the Plants at the Roots: The want of this Motion weakening the Wheat, 'tis (as Animals in the like ſickly caſe are) the more unable to ſtand, and the more liable to be preſs'd down by the Weight of Rain-Water, and more unable to riſe up again when down: All which Evils are remov'd by the free Motion of the Air, which ſhakes off both Dews and Rains, and thus contributes to prevent the falling (or lodging) of Wheat.

A great Quantity alſo of the Sun's Rays is neceſſary to keep Wheat ſtrong and in Health; and in *Egypt* and other hot Countries, it is not ſo apt to fall, as it is when ſown in Northern Climates, tho' the Produce of the South be the greateſt.

It may be obſerv'd, that every Leaf is inſerted into a ſort of Knot, which probably delivers out the Sap to be depurated at the *Veſiculæ* of the Leaves, and then receives it back again for the Nouriſhment of the Plant, doing for that purpoſe the Office of an Heart: But the Sun with his Rays ſupplies the Part of Pulſe, to keep the Sap in Motion, and carry on its Circulation, inſtead of the Heart's *Syſtole* and *Diaſtole*. Wheat being doubtleſs originally a Native of a hot Country, requires by its Conſtitution a conſiderable Degree of Heat to bring it to Perfection; and if much of that Degree be wanting, the Wheat will be the weaker, and when the Solar Rays cannot reach the lower parts of the Stalks, the loweſt Leaves and Knots cannot do their Office; for which reaſon the Chyle muſt mount higher before it be made into Sap, and there muſt be then a greater Mixture of crude Chyle next to the Ground, as by the white Colour it appears. By this means that part, which if it had a due ſhare of the Sun's Influence, would be harden'd like a Bone or Spring, for the Support of the Stalks; but for lack of that, becomes more like to a Cartilage, ſoft and weak, unable to ſuſtain the Weight of the bending Ear, which having its greateſt *Impetus* againſt this part, which is moſt feeble to reſiſt it, it yields and lets it fall to the Ground, and then the Grain will be Blighted.

There is alſo another Cauſe of the Blight, and that is the Wheat's coming too late into Bloſſom; the uſual Time is the Beginning of *June*, and if it be later, the Days ſhorten ſo faſt after the Solſtice, that the Autumn of the Year haſtening the Autumn of the Wheat's Life, the full Time of its Pregnancy (1) is not accompliſh'd; and then its Fruit, which is the Grain, becomes as it were abortive, and not full grown. This Time betwixt the Generation, Bloſſoming, and the Maturity of the Grain, is, or ought to be about Two Months.

Therefore 'tis advantageous to haſten what we can, the time of Bloſſoming, and to protract the time of Ripening: And 'tis obſerv'd, that the earlieſt ſown Wheat generally eſcapes the Blight the beſt, becauſe it comes firſt into Bloſſom.

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(1) *Ut enim mulieres habent ad Partum Dies certos, ſic Arbores ac Fruges.* Varro, *Lib.* I. *Cap.* 44.

Menſe Maio. Florent ſic; Frumenta & Ordeum & quæ ſunt ſeminis ſingularis Octo diebus Florebunt, & deinde per Dies 40, *grandeſcunt Flore depoſito Uſque ad Maturitatis eventum.* Palladius, *Pag.* 114, 115.

Quindecim diebus eſſe in Vaginis, Quindecim florere, Quindecim exareſcere, cum ſit maturum Frumentum. Varro, *Lib.* I. *Cap.* 32.

But the different Heat that there is in different Climates, may alter both the Time that Plants continue in Bloſſom, and the Time betwixt the Bloſſoming and the Ripening.

But it was quite otherwiſe, it ſeems, in that Climate where *Virgil* ſays,

> ‘ *Multi ante occaſum Maiæ capere: ſed illos*
> ‘ *Expectata ſeges vanis illuſit ariſtis.*

This, I ſuppoſe, muſt be where the Winters are ſo mild, that if Wheat were ſown early, it might chance to Bloſſom before the Hazard of the nipping Winds were paſt; which often happen there towards *March*, to be the moſt piercing, and might deſtroy the tender Wheat Bloſſoms, and then the Ears muſt be empty. The Winters are ſo mild at *Meſſina*, as without Art to produce Green Peaſe, Cauliflowers, Artichokes, *&c.* as good as we have them in Summer. Therefore Wheat cannot be kept back from Bloſſoming, as it is here by the Froſt; and if their Wheat Harveſt in *Sicily* be about the 20*th* of *May*, (as I have been inform'd) its Time of Bloſſoming is probably in the Beginning of *March*.

Of all the Errors in the Firſt *Georgic* (which I think contains little elſe) *Virgil*'s Remedy againſt the Blight ſeems the moſt Ridiculous.

> ‘ *Qui ne gravidis procumbat* (1) *culmus ariſtis*
> ‘ *Luxuriem ſegetum tenerâ depaſcit in herbâ*
> ‘ *Cum primum ſulcos æquant ſata.*

And leſt the Stem too feeble for the freight,
Shou'd ſcarce ſuſtain the Head's unwieldy weight,

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(1) All the Injury that Ears receive by falling is, that it makes them light, and lodg'd Ears are always lighter than thoſe of the ſame Bigneſs which ſtand; therefore *Virgil* inſtead of *Gravidis* ſhould have ſaid *Levibus*, if he had a due regard to ſtrict Truth, which alone could be of any Service to the Subject He then wrote of; But He plainly miſtook the Cauſe of its falling, which is *Stalks weak at Bottom*. He blunder'd in the fall'n Wheat; whilſt his Eyes and Thoughts were intently fix'd on the Sky, in order both to learn there his Rules of ſteering his Plow, and to find a Vacancy wherein to place the Conqueror of his own Country among the *Stars*.

Sends in his feeding Flocks betimes t'invade
The riſing Bulk of the luxuriant Blade;
E'er yet th'aſpiring Off-ſpring of the Grain
O'ertops the Ridges of the furrow'd Plain.
Dryden.

This indeed prevents the Blight, by doing what the Blight would do, if the Wheat fell down, *i. e.* cauſes the Ears to be light (1).

And we find that thoſe, who practiſe this Method of feeding their Wheat with Sheep in the Spring, to prevent the lodging of it, have moſt commonly their Straw weak, and Ears light.

Theſe *Virgilians*, inſtead of making the Stalks ſtrong enough, to ſupport heavy Ears, make the Ears light enough to be ſupported by weak Stalks, They know that heavy Ears make the greateſt Crop, and yet they ſtill hope to have it from light ones.

They cauſe the *Blight* by the very means they make uſe of to *cure* it.

This feeding of Wheat much retards the time of its Bloſſoming, and that it may bloſſom early is one chief End of ſowing it early, to prevent the Blight. But when it is fed, what the Plants ſend up next is but a ſort of ſecond or latter Crop, which have longer to ſtand than the firſt would have required, and is always weaker than the firſt Crop would have been; and the longer time it has to continue on the Ground, the more Nouriſhment is required to maintain it; and yet, as has been ſhewn, the longer it has been ſown, the more the Earth has loſt of its Nouriſhment; and conſequently, the Crop will be yet weaker and in more Danger of the ſtarving Blight.

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(1) Heavy Ears never fall, if they did, that would not make them light. Wheat falls ſometimes whilſt 'tis in Graſs, and before it comes into Ear; ſo far are the Ears from cauſing it to fall.

Thus *Virgil's* Remedy ſeems here to be worſe than the Diſeaſe (1).

The moſt effectual Remedy againſt the Blight, is that which removes all its Cauſes, (except ſuch extraordinary ones as Lightning) as,

Firſt, *Want of Nouriſhment.*

The Horſe-Hoe will, in wide Intervals, give Wheat throughout all the Stages of its Life, as much Nouriſhment as the diſcreet Hoer pleaſes.

Secondly, *Want of Air.*

Air being a Fluid, moves moſt freely in a right or ſtraight Line; for there the feweſt of its parts meet with any Reſiſtance; as a ſtraight River runs ſwifter than a crooked one, from an equal Declivity; becauſe more of the Water ſtrikes againſt the Banks at the Turnings, and is there ſomewhat retarded; and the reſt moving no faſter than in the ſtraight River, the whole Stream of the Crooked muſt be ſlower in its Courſe, than that of the ſtraight River.

The Air cannot paſs thro' ſown Corn in a direct Line, becauſe it muſt ſtrike againſt, and go round every Plant, they ſtanding all in the way of its courſe, which muſt ſtop its Current near the Earth.

And the Air amongſt ſown Corn, is like Water amongſt Reeds or Oſiers in the ſide of a River, 'tis ſo ſtopp'd in its Courſe, that it almoſt becomes an Eddy; and ſince Air is about eight Hundred times lighter than Water, we may ſuppoſe its Current thro' the Corn is more eaſily retarded, eſpecially near the Earth, where the Corn has occaſion for the greateſt Quantity of Air to paſs: For tho' the upper part of the Wheat be not able to ſtop a ſlow Current of Air, yet it does ſo much raiſe even a ſwift one, as to throw it off from the Ground, and hinder it from reaching the lower parts of the Stalks, where the Air muſt therefore remain, in a manner, ſtagnant; and the thicker the Wheat is, where it ſtands promiſcuouſly, the leſs change of Air can it have, tho' the greater the Number of the Stalks is, the more freſh Air they muſt require.

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(1) I am ſure, that whenever Sheep break into my Drill'd Wheat, in the Spring, it leſſens my Crop half, juſt as far as they eat the Rows.

But the confuſed manner in which the Plants of ſown Wheat ſtand, is ſuch, that they muſt all oppoſe the free Entrance of Air amongſt them, from whatever Point of the Compaſs it comes.

Now it is quite otherwiſe with Wheat drill'd regularly with wide Intervals, for therein the Current of Air may paſs freely, (like Water in a ſtraight River where there is no Reſiſtance) and communicate its Nitre to the lower as well as upper Leaves, and carry off the Recrements they emit, not ſuffering the Plants to be weaken'd, as an Animal is, when his Lungs are forced to take back their own Expirations, if debarr'd from a ſufficient ſupply of freſh untainted Air. And this Benefit of freſh Air is plentifully and pretty equally diſtributed to every Row in a Field of Hoed Wheat.

Thirdly, *Want of the Sun's Rays.*

Sown Wheat Plants, by their irregular Poſition, may be ſaid to ſtand in one another's Light, for want of which they are apt to fall.

'Tis true the whole Field of Plants receive the ſame quantity of Sun-Beams amongſt them, whether they ſtand confuſedly or in order; but there is a vaſt difference in the Diſtribution of them, for none or the very leaſt ſhare of Beams is obtaind by thoſe parts which need the greateſt ſhare, in the confuſed Plants. And when the Crural Parts, that ſhould ſupport the whole Body of every Plant, are depriv'd of their due ſhare of what is ſo neceſſary to ſtrengthen them, the Plants (like Animals in the ſame caſe) are unable to ſtand.

But in drill'd Wheat, where the Plants ſtand in a regular order, the Sun-Beams are more duly diſtributed to all parts of the Plants in the Ranks; for which way ſoever the Rows are directed, if they be ſtraight, the Rays muſt, ſometime of the Day, fall on the Intervals, and be reflected by the Ground, whence the lower parts of the Wheat-ſtalks muſt receive the greater ſhare of Heat, being neareſt to the Point of Incidence, having no Weeds to ſhadow them.

As to that Cauſe of the Blight, *viz.* the Wheat's dying before the full time of its Pregnancy be accompliſh'd; the Hoe removes all the Objections againſt planting early, and then it will bloſſom the earlier: and it has viſibly kept Wheat green a whole Week longer, than unhoed Wheat adjoining to it, planted the ſame Day.

The Ancients were perfect Maſters of the Vine-Husbandry, which ſeems to have engroſs'd their rural Studies, that it did not allow them ſo much reflection, as to apply the uſe of thoſe Methods to the Encreaſe of Bread, which they had diſcover'd to be moſt beneficial for the Encreaſe of Wine. One Method was to Hoe the Vines after they had bloſſom'd, in order to fill the Fruit, as in *Columella*, Lib. 4. Cap. 28. *Convenit tum crebris Foſſionibus implere, nam fit uberior Pulverationibus.* And if what *Palladius* ſays, *Tit. ix.* be true of the Sarritions and Sarculations in the Month of *January*, and that if Beans do twice undergo that ſcratching Operation, they will produce much Fruit, and ſo large as to fill the Buſhel almoſt as full when ſhal'd as unſhal'd.

Faba ſi bis Sarculetur proficiet, & multum fructum & maximum afferet, ut ad menſuram Modii complendi Freſa propemodum ſicut integra reſpondeat.

This is to be done when Beans are four Fingers high, and Corn when it has four or five Leaves to a Plant ; even then the Harrowing-work, tho' it tore up ſome of the Plants, yet it was obſerv'd to do good againſt the Blight.

Si ſiccas ſegetes ſarculaveris, aliquid contra Rubiginem præſtitiſti, maxime ſi ordeum ſiccum ſarrietur.

When the Ancients obſerv'd this, 'tis wonder they did not plant their Corn ſo as to be capable of receiving this Benefit in Perfection. They might have imagin'd, that what was effectual againſt the Blight, when the Corn was in Graſs, muſt, in all probability, be much more effectual when in Ear.

But the moſt general Blight, that happens to Wheat in cold Climates, is cauſed by Inſects, which (ſome think) are brought in the Air by an Eaſt-Wind accompany'd with Moiſture, a little before the Grain is filling with that Milky-Juice, which afterwards hardens into Flour. Theſe Inſects depoſite their Eggs within the Outer Skin (or Rind) of the Stalks ; and when the young ones are Hatched, they feed on the *Parenchyma*, and eat off many of the Veſſels which ſhould make and convey this Juice ; and then the Grain will be more or leſs thin in proportion to the Number of Veſſels eaten, and as the Inſects happen to come earlier or later ; for ſometimes they come ſo late, that the Grain is ſufficiently filled with the ſaid Milky-Juice before the Veſſels are eaten ; and then, tho' the Straw appear through a Microſcope to have its Veſſels very much eaten and torn, and to be full of Black Spots (which Spots are nothing elſe but the Excrements of thoſe young

Inſects) yet the Grain is plump and not blighted, there being an Obſervation, That the early ſown Wheat generally eſcapes this Blight. And it has been ſeen, where one part of a Field is ſown earlier than the other part, without any other Difference than the time of ſowing, that the Grain of the lateſt ſown has been much blighted, and the Grain of the earlier has eſcaped the Blight, tho' the Straw of both were equally eaten by the Inſects. Hence it may be inferr'd, that the Milk in the one had received all the Nouriſhment neceſſary to its due Conſiſtence, before the Veſſels were deſtroy'd; but in the other, the Veſſels, which ſhould have continued the ſupply of Nouriſhment for Thickening the Milk, being ſpoil'd before they have finiſh'd that Office, it remains too thin; and then the Grain, when it hardeneth, ſhrinks up and is blighted; yet the Grain of one and the other are equally plump until they become hard; the Difference therefore is only in the Thickneſs of the Milk, That in the blighted being more Watry than the other.

The chief Argument to prove that theſe Inſects are brought by an Eaſt-Wind, is, That the Wheat on the Eaſt-ſides of Hedges are much blighted, when that on the Weſt-ſides is not hurt; and as to the Objection, that they are bred in the Earth, and crawl thence up the Stalks of the Wheat, becauſe ſome Land is much more ſubject to produce blighted Wheat than other Land is, perhaps this difference may be chiefly owing to the different Situation of thoſe Lands, as they are oppoſed to the *Eaſt* or to the *Weſt*.

Another Cauſe why ſome Wheat is more blighted than other Wheat on the ſame Land, is, the different Condition in which the Inſects find it; for the Rind of that which is very ſtrong and flouriſhing

ing (1) is ſoft and tender; into this they can eaſily penetrate to lay their Eggs; but the Wheat that is poor and yellow, has a hard tough Skin (or Rind) into which the Inſects are not able to Bore, for the Intromiſſion of their Eggs, and therefore can do it no Miſchief. It would be in vain to adviſe to prevent the Blight, by ſtriving to make the Wheat poor; for tho' Poverty may preſerve Wheat from this Blight, as well as it does People from the Gout, yet that is a Remedy which few take willingly againſt either of theſe Diſeaſes: But this I think might be poſſible to remedy it, if we could from the ſtrongeſt Wheat take away ſo much Nouriſhment as to turn its Colour a little yellowiſh juſt before the Inſects come (2), which I ſuppoſe to be in *June*, after the Ear is out, or at leaſt fully formed.

Yet this can only be done in wide Intervals, for unleſs the fine Earth can be thruſt to ſome conſiderable Diſtance from the Roots after they are cut off, they will ſoon ſhoot out again and reach it, becoming more vigorous thereby.

In dry Summers this Misfortune ſeldom happens, much Heat and very little Moiſture being moſt agreeable to the Conſtitution of Wheat; for then its Rind is more Firm and hard, as it is on the contrary made more ſoft and ſpongy by too much Moiſture.

The moſt eaſy and ſure Remedy that I have yet found againſt the Injury of theſe Inſects, is to plant a ſort of Wheat that is leaſt liable to be hurt by them, *viz.* the *White-Cone* (or Bearded) *Wheat*, which has its Stalk or Straw like a Ruſh, not hollow but full of Pith, (except near the lower part, and there 'tis very thick and ſtrong) 'tis probable it has Sap-Veſſels that lie deeper, ſo as the young Inſects cannot totally deſtroy them, as they do in other Wheat: For when the Straw has the Black Spots, which ſhew that the Inſects have been there Bred, yet the Grain is plump, when the Grey-Cone and Lammas-Wheat mixt with it are Blighted. This Difference might have been from the different times of Ripening, this being Ripe about a Week earlier than the Grey-Cone, and later than the Lammas: But its being planted together both early and late, and at all times of the Wheat-ſeed time, and this White-Cone always eſcaping with its Grain unhurt, is an Argument, that 'tis naturally fortify'd againſt the Injury of theſe Inſects, which in wet Summers are ſo pernicious to other ſorts of Wheat; and I can impute it to no other Cauſe than the different Deepneſs of the Veſſels, the Straw of other Wheat being very much thinner and hollow from top to bottom, this having a ſmall hollow at bottom, and there the Thickneſs betwixt the outer Skin and the Cavity, is more than double to that in other ſorts of Wheat; ſo that I imagine, the Inſects reach only the outermoſt Veſſels, and enough of the inner Veſſels are left untouch'd to ſupply the Grain.

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(1) Some ſort of Land is more ſubject to this Blight than others, in ſuch, Lammas-Wheat muſt by no means be drill'd Late and too Thin, leſt it ſhould not Tiller till late in the Spring; and then, for want of a ſufficient Quantity of Stalks to diſpenſe with all the Nouriſhment rais'd by the Hoe, may become too vigorous and luxuriant, and be the more liable to the Injury of the Blight of Inſects.

(2) Whither thoſe Inſects go, or where they reſide, from the time of their Eating their way out of the Straw, until they return the next Year, I cannot learn.

This Wheat makes very good Bread, if the Miller does not grind it too ſmall, or the Baker make his Dough too hard, it requiring to be made ſofter than that of other Flour.

A Buſhel of this White-Cone-Wheat, will make more Bread than a Buſhel of Lammas, and of the ſame

Goodneſs; but it gives a little yellow Caſt to the Bread.

Another ſort of lodging Blight there is, which ſome call *Moar-Loore*, and moſtly happens on light Land; this is when the Earth ſinking away from the Roots, leaves the bottom of the Stalk higher than the ſubſided Ground, and then the Plant having only theſe naked Roots to ſupport it (for which they are too weak) falls down to the Earth.

To Remedy this, Turn a ſhallow Furrow againſt the Rows, when they are ſtrong enough to bear it, and when the Mould is very fine and dry; then the Motion of the Stalks by the Wind, will cauſe ſuch Earth to run thorough the Rows, and ſettle about the Roots and cover them.

I have never ſeen any drill'd Wheat ſo much ſpoil'd by falling, as ſown Wheat ſometimes is. The Drill'd never falls ſo cloſe to the Ground, but that the Air enters into Hollows that are under it, and the Wind keeps the Ears in Motion. Notwithſtanding all the Precaution that can be uſed, in ſome unſeaſonable Years Wheat will be Blighted: I have known ſuch a general Blight, when ſome of my Lammas-Wheat, planted late and on blighting Land, was blighted amongſt the reſt of my Neighbours, by the Inſects; but the Grain of the ſowed Wheat was vaſtly more injur'd than that of the Drill'd: The former was ſo *light*, that the greateſt part was blown away in Winnowing, and the remainder ſo *bad*, that it was not fit to make Bread: The Drill'd made as good Bread, and had as much Flour in it, as the ſow'd Wheat had, that was not blighted; for the Grains of the Drill'd were much larger than thoſe of the ſown; being form'd to have been Twice as big as the Grains of Wheat generally are, had they not been blighted.

Chap. XIV. *Of* St. *FOIN.*

St. *FOIN*, from the Country we brought it from, is call'd *French Graſs*: And for its long Continuance, ſome having laſted Forty Years, 'tis call'd *Everlaſting Graſs*, tho' it be not ſtrictly a *Gramen.*

'Tis call'd in *French*, *Sain Foin*, i. e. *Sanum Fœnum*, from its Quality of Wholeſomneſs, beyond the other artificial Graſſes, green and dry. 'Tis alſo call'd *Sanctum Fœnum*, Holy Hay.

'Tis a Plant ſo generally known to every body (except a certain Author, who confounds it with *Medica)* that there is no need to give any formal Deſcription of that part of it which appears above Ground. It has many Red Flowers, ſometimes leaving Ears five or ſix Inches long: I have meaſured Stalks, and found them above Five Foot long, tho' they are commonly but about two Foot.

The Reaſon why *St. Foin* will, in poor Ground, make a Forty times greater Encreaſe than the natural Turf, is the prodigious Length (1) of its perpen-

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(1) There is a Vulgar Opinion, that *St. Foin* will not ſucceed on any Land where there is not an under *Stratum* of Stone or Chalk, to ſtop the Roots from running deep, elſe they ſay the Plants ſpend themſelves in the Roots only, and cannot thrive in thoſe parts of them which are above the Ground. I am almoſt aſhamed to give an Anſwer to this.

'Tis certain that every Plant is nouriſhed from its Roots (as an Animal is by its Guts) and the more and larger Roots it has, the more Nouriſhment it receives, and proſpers in proportion to it. *St. Foin* always ſucceeds where its Roots run deep, and when it does not ſucceed, it never lives to have long Roots; neither can there ever be found a Plant of it, that lives ſo long as to root deep in a Soil that is improper for it. Therefore 'tis amazing to hear ſuch Reaſoning from Men.

An

pendicular Tap-Root; it is ſaid to deſcend Twenty or Thirty Foot. I have been inform'd by a Perſon of undoubted Credit, that he has broke off one of theſe Roots in a Pit, and meaſured the Part broken off, and found it Fourteen Foot.

This Tap-Root has alſo a Multitude of very long Horizontal Roots at the upper part thereof, which fill all the upper *Stratum*, or Staple of the Ground; and of Thouſands of St. Foin Roots I have ſeen taken up, I never found One that was without Hozizontal Roots near the Surface, after One Summer's Growth; and do much wonder how Mr. *Kerkham* ſhould be ſo miſtaken, as to think they have none ſuch.

Alſo theſe Tap-Roots have the Horizontal ones all the way down; but as they deſcend, they are ſtill ſhorter and ſhorter, as the uppermoſt are always the longeſt.

Any dry Ground may be made to produce this noble Plant, be it never ſo poor; but the richeſt Soil will yield the moſt of it, and the beſt.

If you venture to plant it with the Drill, according to the Method wherein I have always had the beſt Succeſs; let the Land be well prepared before you plant it. The Seed if not well ordered will very little of it grow; therefore 'tis convenient to try it in the Manner mention'd in Chapter of *Hoeing*; where are alſo Directions to find the proper Quantity and Depth to plant it at: I have obſerv'd that

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An under *Stratum* of very ſtrong Clay or other Earth which holds Water, may make a Soil improper for it; becauſe the Water kills the Root, and never ſuffers it to grow to Perfection, or to attain to its natural Bulk. The beſt *St. Foin* that ever I ſaw, had nothing in the Soil to obſtruct the Roots, and it has been found to have Roots of a prodigious Depth.

the Heads of theſe Seeds are ſo large, and their Necks ſo weak (1), that if they lie much more than half an Inch deep (2), they are not able to riſe through the incumbent Mould; or if they are not cover'd, they will be Malted (3). A Buſhel to an Acre is full Twenty Seeds to each ſquare Foot in all I try'd; but there is odds in the Largeneſs of it, which makes ſome Difference in the Number.

The worſt Seaſons to plant it are the Beginning of Winter, and in the Drought of Summer: The beſt Seaſon is early in the Spring.

'Tis the ſtronger when planted alone, and when no other Crop is ſown with it (4).

If Barley, Oats, or other Corn ſown with *St. Foin* do lodge, it will kill (1) the young *St. Foin* that is under it: But then ſo great a Crop of Corn will certainly anſwer the very little Expence of Drilling the *St. Foin* again, either the next Year, or as ſoon as the Corn is off the Ground.

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(1) The Kernel or Seed, being much ſwollen in the Ground, I call the Head; this when it reaches above the Ground, opens in the Middle, and is formed into the two firſt Leaves; the Husk always remaining at the ſame Depth at which it is cover'd: the String that paſſes from the Husk to the Head, is the Neck; which, when by its too great Length 'tis unable to ſupport the Head till it reaches to the Air, riſes up and doubles above it; and when it does ſo, the Head being turn'd with its Top downwards, never can riſe any higher, but there rots in the Ground.

(2) In very light Land the Seed will come up from a greater Depth; but the moſt ſecure way is, not to ſuffer it to be cover'd deep in any Land.

(3) We ſay it is Malted when it lies above Ground, and ſends out its Root, which is killed by the Air. And whether we plant *bad* Seed that does not grow, or *good* Seed buried or malted, the Conſequence will be much the ſame, and the Ground may be equally underſtock'd with Plants.

(4) The worſt Crop that can be ſown amongſt St. Foin, is Clover or Rye-Graſs; Barley or Oats continue but a little while to rob it, but the other Artificial Graſſes rob it for a Year or Two, until the Artificial Paſture is near loſt; and then the *St. Foin* never arrives to half the Perfection as it will do when no other Graſs is ſown amongſt it.

The Injury theſe Hay Crops do to the *St. Foin* is beſt ſeen where ſome parts of the ſame Field have them, and the other parts are without them.

St. Foin Drill'd betwixt Rows of Barley or Oats, always is ſtronger than when Drill'd amongſt Corn that is ſown at Random; and therefore is in leſs Danger of being kill'd by the Lodging of the Corn; neither is the Corn in Rows ſo liable to fall as the other.

The Quantity of Seed to be Drill'd on an Acre will depend in great meaſure upon the Goodneſs of it; for in ſome bad Seed, not more than One in Ten will grow, and in good Seed, not One in Twenty will miſs; which is beſt known by ſtripping off the Husks of a certain Number of Seeds, and planting the Kernels in Earth, in the Manner directed for finding the proper Depth to plant at, which in this caſe let be half an Inch; this being done, the Quality of the Seed will be known; but until frequent Trials have furniſh'd Experience enough to the Planter to know the Difference, let him obſerve that the following are good Signs, *viz.* The Husk of a bright Colour, the Kernel plump, of a light Grey or Blew Colour, or ſometimes a ſhining Black; yet the Seed may be good, tho' the Husk is of a dark Colour, if that is cauſed by its receiving Rain in the Field, and not by Heating in a Heap, or in the Mow; and if you cut the Kernel off in the Middle, croſs-ways, and find the Inſide of a greeniſh freſh Colour, it's ſurely good; but if of a yellowiſh Colour, and Friable about the Navel, and Thin, or Pitted, theſe are Marks of bad Seed.

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(1) When Barley, among which the *St. Foin* is planted in a dry Summer, is great, there are few Farmers that know till the next Spring, whether the *St. Foin* ſucceeds or not; becauſe the young Plants are not then Viſible; unleſs it be to thoſe who are accuſtomed to obſerve them in all the Degrees of their Growth. I have ſeen a Field of Ten Acres of ſuch, wherein, after the Barley was carry'd off, nothing appeared like *St. Foin*; but when by the Print of the Channels I ſearched diligently, I found the ſmall *St. Foin* Plants thick enough in the Rows; they had no Leaves, they being cut off by the Scythe, no part of them that was left had any green Colour; but from the Plants there came out many Sprigs like Hog's Briſtles, or like the Beard of Barley: This whole Piece of *St. Foin* ſucceeded ſo well, that the Third Year its Crop was worth Three Pounds per Acre, the Land being good.

The Quantity, or rather Number of Seeds convenient to Drill, ought to be computed by the Number of Plants (1) we propoſe to have for making the beſt Crop, allowing for Caſualties (2).

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(1) Not that we need to be ſo exact as to the Number of Plants, whether they be Two, Three, or Four Hundred upon a ſquare Perch. Neither is it poſſible to know before-hand the preciſe Number of Plants that may live, for ſometimes the Grub kills many, by eating off the firſt Two Leaves.

(2) Many even of the beſt Seeds, both Sown and Drill'd, are liable to Caſualties, but not equally; for about Twenty-eight Years ago, my Servants (being prime Seeds-Men) had a Fancy in my Abſence to Try an Experiment of the Difference betwixt Sowing and Drilling of *St. Foin*; and in the Middle of a large Field of my beſt Land, they ſow'd a ſquare Piece of Three Acres, at the rate of One Buſhel to an Acre, not doubting, but by their skill in ſowing *even*, it would ſucceed as well as if Drill'd; but it ſucceeded ſo much againſt their Expectation, that the Land all round it, which was Drill'd at the ſame time, with the ſame proportion of the ſame Seed, brought extraordinary good Crops of *St. Foin*; but the ſow'd part was ſo very thin, that tho' it lay'd ſtill with the reſt for Eight Years, it never was a Crop, there not being above Three or Four upon a ſquare Perch, taking the Three Acres all together; not that it can be ſuppoſed, that the ſown would always meet with ſo many Caſualties as this did; for then Eight Buſhels ſown to an Acre might have been too Thin, and much Thinner than all the reſt of the Field was, tho' Drill'd with only One Buſhel to an Acre: And 'tis often ſeen, that when an Acre is ſown with Seven Buſhels of Seed, the *St. Foin* is as much too Thick, as that ſown with One Buſhel was too Thin.

In Drilling *St. Foin* not to be Hoed, and before the Plows of my Drill were ſo perfect in making narrow Channels as they are now, (for when the Channels were open, they had ſix times the Breadth, wherein part of the Seed was waſted) then my Quantity was One Buſhel to an Acre, ſometimes Six Gallons.

But a ſingle Acre (in the middle of a large Field of *St. Foin*) being Drill'd late in *October*, the froſty Winter kill'd at leaſt Nineteen of Twenty Parts (1) of that Buſhel. At firſt it made ſuch a poor Appearance, that 'twas by mere Accident, or it had been plow'd up for a Fallow; but miſſing of that, a few Plants were perceiv'd in the Summer, which by their Singleneſs grew ſo vigorous and ſo very large, that the ſecond Year of mowing it, produc'd a Crop Double to the reſt of the ſame Field which was Drill'd in the Spring, with the ſame proportion of Seed, and none of it kill'd; tho' all this Field was a much better Crop than ſome that was ſown in the common Manner, with ſeven Buſhels to an Acre. I have generally obſerv'd the Thin (2) to make the beſt Crop, after the Firſt or Second Year.

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I do not know, that of the many Hundred Acres of *St. Foin*, that have been Drill'd for me, ever One Acre was too Thin, except when planted with Wheat, the young Plants were kill'd by the Froſt.

(1) But I believe, there might remain *alive* Three or Four Plants to each ſquare Yard, ſtanding ſingle and at pretty equal Diſtances.

(2) But notwithſtanding I commend the planting of St. Foin Thin, that moſt of the Roots may be ſingle; yet I have Fields that were drill'd with but Four Gallons of Seed to an Acre; and yet the Rows being ſeven Inches aſunder, the Roots are ſo thick in them, that the Ground is cover'd with the St. Foin Plants, which ſeem to be as thick (in appearance) as moſt ſown St. Foin, whereon Seven or Eight Buſhels are ſown on an Acre. And I have other Fields that were drill'd with about Two Gallons of Seed to an Acre (which is Five Seeds to each ſquare

Foot)

I have alſo often obſerv'd in Lands of St. Foin, lying diſpers'd in a common Field, (but where there was not Common for Sheep) and where the Ends of other Lands kept in Tillage, pointed againſt the Pieces of St. Foin, and the Horſes and Plows turning out upon the St. Foin, did plow and ſcratch out a Multitude of its Plants; ſo that it was thought to be ſpoil'd, and Law-ſuits were intended for Recompence of the Damage: But afterwards this ſcratch'd part, ſuppoſed to be ſpoil'd, became Twice as good as the reſt of the ſame Pieces, where the Plows did not come to tear up any Plants.

The Reaſon why the ſingle St. Foin Plants make the greateſt Crops, is, That the Quantity of the Crop is always in Proportion to the Quantity of Nouriſhment it receives from the Earth, and thoſe Plants which run deepeſt will receive moſt, and ſuch as are ſingle will run deeper than thoſe which are not ſingle.

Alſo the ſingle do ſend out all round them Horizontal Roots, proportionably ſtronger and larger, whereby they are better able to penetrate, and extract more Nouriſhment from the Staple or upper *Stratum*, than the other can do (if there be a competent Number, which is when Hoed fewer than any Body imagines.) 'Tis common to ſee a ſingle St. Foin have a bigger Tap-Root than Twenty thick ones; their Length is in proportion to their Bigneſs, therefore that ſingle Plant may well be ſuppoſed to have Twenty times more Depth of Earth to ſupply it, than all thoſe Twenty ſmall Roots can reach to. And tho' theſe under *Strata* are not ſo rich

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Foot) the Rows Sixteen Inches aſunder, that produce better Crops, tho' the Ground be poorer. The drill'd St. Foin being regular is more ſingle, tho' as thick as the ſown, and for that Reaſon always makes a better Crop, and laſts longer than the ſown that is of the ſame thickneſs but irregular.

rich as the upper, yet never having been drain'd by any Vegetable, they do afford a very conſiderable Quantity of Nouriſhment to thoſe Roots which firſt enter them.

The ſmall thick Plants are ſo far from equalling the Product of the ſingle, by their exceſs of Number, that the more they are, the ſmaller, ſhorter and weaker they become; leſs Nouriſhment they have, and the leſs Crop they produce, and are ſoon ſtarv'd, decay and die, unleſs reliev'd by the Expence of frequent Manure, or that the Soil be very rich.

Single Plants exceed the other by a Multitude of Degrees, more than a Giant does a Dwarf in Strength, as well as Stature; and therefore when natural Graſs happens to come, are ſo much the better able to ſhift amongſt it.

The ſingle Plants ſeem alſo to exceed the other in their Longevite; for 'tis obſerv'd, that all St. Foin that has continued good, for a great Number of Years without Manure, has been ſo ſingle, that the Owners have determined to plow it up at the Beginning, for the Thinneſs of it.

How long this may laſt by Culture I can't tell, but undoubtedly much longer than without it; and I can ſay, that I never knew a Plant of St. Foin die a natural Death; the moſt common End of it is ſtarving. And when an Hundred Thick Plants have not the Nouriſhment which One ſingle Plant has, 'tis no wonder that theſe (in a Croud (1) thus beſieg'd with Hunger) ſhould be ſtarv'd before it.

Another Advantage the Single have, in reſpect of Moiſture, theſe reach to a Depth where that is never wanting, even when the upper *Stratum* or Staple is parch'd up, as appears by the *Mint (G)* in the Glaſs and Box, that if any Root of a Plant has Moiſture, that Root will communicate a ſhare to all the reſt. Hence it is, that in the drieſt Summer, theſe ſingle Plants make a great Crop, when the other yield next to nothing. I remember I once ſaw a Farmer coming out of a Ground with a Load of St. Foin Hay, which he aſſured me was all he could find worth cutting out of Forty Acres, of this thick ſort in full Perfection, Three Years after ſowing; he valued his Load at Three Pound, but withal ſaid, it came off ſo much Ground, that the Expence of Mowing, Raking, *&c.* was more than the Value. When in the very ſame dry Summer, there was Three Tun of St. Foin to an Acre in a Field, where it was Drill'd ſingle and regularly.

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(1) Sown Plants when too Thick are *Crowded* on every ſide, but thoſe that are Drill'd, have always Room enough on Two ſides of them; unleſs the Rows are too near together.

And I have often obſerv'd, that where the Plants are thin, the ſecond Crop of them ſprings again immediately after Cutting; when Plants that ſtand thick in the ſame Ground, ſpring not till Rain comes: And I have ſeen the thin-grown high enough to cut the ſecond time, before the other begun to ſpring.

The beſt way to find what Number of theſe Plants is proper to have on a Perch of Ground, is to conſider what Quantity of Hay one large Plant will produce (for if Cultivated, they will be all ſuch.)

Without Culture theſe Plants never attain to a Fourth part of the Bulk they do with it, therefore very few have ſeen any one Plant at its full Bigneſs; one Plant well Cultivated has in the ſame Ground made a greater Produce than One Thouſand ſmall ones Uncultivated.

But the Hay of a large ſingle Cultivated Plant will weigh more than Half a Pound; and 112 Plants upon a ſquare Perch, weighing but a Quarter of a Pound a piece one with another, amount to Two Tun to an Acre.

If St. Foin be planted on ſome ſorts of Land early in the Spring and Hoed, it may bring a Crop the ſame Summer; for I once planted a few Seeds of it on Sandy Ground in my Garden, at the End of *February*, which produced large Plants above Two Foot high, that went into Bloſſom the following *June*, tho' there was a ſevere Froſt in *March*, which kill'd abundance of Wheat, yet did not hurt theſe Plants: This ſhews that St. Foin is a quick grower, unleſs it be planted on poor cold Ground, or for want of Culture.

And tho' the poor Land and ill Management generally allotted to it, cauſes it to yield but One mowing Crop a Year, yet it has yielded Two great ones on rich ſandy Land, even when ſown in the common ordinary manner.

Thin St. Foin cannot be expected to cover all the Ground at firſt, no more than an Orchard of Apple-Trees will, when firſt planted, at Thirty Foot diſtance from each other every way, yet this is reckon'd a proper Diſtance to make a good and laſting Orchard. But if theſe ſhould be planted at Three Foot diſtance, as they ſtand in the Nurſery, it would not be more unreaſonable than the common Method of ſowing St. Foin is; and there would be much the ſame Conſequence in both, from covering all the Ground at firſt planting; except that the St. Foin being abundantly longer Rooted downwards, than Apple-Trees are, has the greater Diſadvantage, when by its Thickneſs 'tis prevented from growing to its full Bulk, and Length of Roots (1).

The Difference is only this, People are accuſtom'd to ſee Apple-Trees planted at their due Diſtance, but few have ſeen St. Foin planted and cultivated at the diſtance moſt proper to St.Foin,or ever conſider'd about it, ſo much as to make the neceſſary Trials.

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(1) Horizontal-rooted Plants ſuffer no greater Injury by their Paſtures being overſtock'd than Cattle do; becauſe their Paſture lying near the Surface of the Ground, they have it all amongſt them: But St. Foin, and other long Tap-rooted Plants ſuffer yet more, becauſe great part of their overſtock'd Paſture is

I have conſtantly found, that upon doubling any Number of narrow Rows, having equal Number of Plants in each Row, the Crops have been very much diminiſh'd; and upon leaving out every other Row, that is, leſſening the Number of Rows to Half, the Crops are encreaſed: And where Two Rows are wide aſunder at one End of a Piece, and near at the other End, the Plants are gradually leſs and leſs, as the Rows approach nearer together.

We ought never to expect a full Crop of St. Foin the Firſt Year, if we intend to have good Crops afterwards; and that it ſhall continue to produce ſuch, for the ſame Reaſons that muſt be given for Planting an Orchard at other Diſtances than a Nurſery.

The common Error proceeds from miſtaking the Cauſe of a great or ſmall Crop.

Where the ſpaces betwixt Rows are wide (if there be not too many Plants in them) we always ſee the St. Foin grow large, and make the greateſt Crop; but when it is young, or after cutting, we ſee room (as we fancy) for more of ſuch Plants, to make a yet larger Crop; not conſidering that 'tis the Wideneſs of thoſe Spaces,and leſs Number of Plants,that cauſe the Crop to be ſo large, there being more Paſture for thoſe Plants.

Where theſe ſpaces are Narrower, and the Rows of equal Thickneſs, we ſee the Plants leſs when grown, and that they make a leſs Crop, and yet there ſeems to be Room for more Rows, which we fancy might make the Crop larger, not conſidering that 'tis the Narrowneſs of thoſe ſpaces that cauſe

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is loſt by them all, when they hinder one another from reaching down to it, by ſhortening One Another's Roots, which they do when they all become Dwarfs by reaſon of their over-thickneſs.

the Plants and Crop to be leſs, for want of ſufficient Paſture.

Thus fondly encreaſing the Number of our Rows and Plants, we bring our Crop (unleſs the Soil be rich) to nothing, by too much overſtocking their Paſture: And if that Paſture be overſtock'd, the Crop will be diminiſh'd more than in proportion to that over Charge; for perhaps 'tis not impoſſible to prove (if we would be curious) that Plants by wanting a Fourth part of their due *Quantum* of Nouriſhment, will be diminiſh'd to Half (1) of their Bulk they would have attained to, had they been ſupply'd with the other Fourth part.

I have obſerv'd Hoed St. Foin to grow more, and encreaſe its Bulk more in Two Weeks, than Unhoed St. Foin in the ſame Ground (and without any other Difference) hath done in ſix Weeks: and the quicker it grows by being better fed, the ſweeter and richer Food it will make for Cattle, whether it be ſpent Green or Dry (2).

At whatever Diſtance the Rows be ſet, if they have too many Plants in them, the Crop will be very much injur'd; and the greater the Exceſs is beyond the juſt Number, the more void ſpace there will be amongſt them; becauſe the ſmaller the Plants are, the leſs Ground they cover.

I have had the Experience of Drilling at all Diſtances, from Thirty Three Inches to Seven Inches, betwixt the Rows; and recommend the following Diſtances,

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(1) When Plants have not their due Nouriſhment they ſuffer the more by Cold, and Drought, ſo that want of Nouriſhment diminiſhing their Growth one Fourth, Cold, or Drought, or both may diminiſh it another Fourth.

(2) Cattle are the beſt judges of the Goodneſs of Graſs, and they always choose to feed on St. Foin that is moſt Vigorous, and refuſe that which is Poor and Yellow. And the Richeſt Sweeteſt Graſs will always make the beſt Hay; for the drying of it does not change the Quality of the Graſs.

tances, for the different Methods of Drilling; whether the St. Foin be deſign'd for Hoeing, or not. As,

Firſt, For *Horſe-Hoeing*, I think it is beſt to Drill Double Rows with Eight-Inch Partitions, and Thirty-Inch Intervals, which need only be Hoed alternately, leaving every other Interval for making the Hay thereon.

Indeed I have never yet had a whole Field of Hoed St. Foin; but have enough to ſhew, that Horſe-Hoeing makes it ſtrong upon very poor Land, and cauſes it to produce Two Crops a Year upon indifferent Land.

It is not neceſſary to Hoe this every Year; but we may intermit the Hoeing for Three or Four Years together, or more if the Land be good.

Whilſt the Plants are ſmall the firſt Year, care muſt be taken not to cover them with the Plow; afterwards there will be no great Danger, eſpecially in Winter, the Earth not being ſuffer'd to lie on them too long.

Secondly, For *Hand-Hoeing*, Drill the Rows ſixteen Inches aſunder, and ſingle out the Plants, ſo as to make them Eight Inches apart at leaſt in the Rows, contriving rather to leave the Maſter-Plants, than to be exact in the Diſtance; this muſt be done whilſt they are very young, or in Summer; elſe they will come again that are cut off by the Hoe.

Laſtly, When St. Foin is Drill'd without any Intention of Hoeing, the beſt way (I think) is to plant ſingle Rows, at eight Inches diſtance, with no greater Quantity of Seed, than when the Rows are at ſixteen Inches Diſtance; becauſe by this Method, the ſame Number of Plants in the Rows, that are but eight Inches apart, will be much more ſingle, than in the Rows at ſixteen Inches apart are, without being ſet out by the Hoe.

Which of theſe Methods ſoever is practis'd, the Land ſhould be made as clean from all Graſs, and as well pulveriz'd as poſſible, before Drilling.

The Tines of the Drill-Harrow muſt exactly follow the Shares, which leaving the Channels open, the Tines cover the Seed, ſome at Bottom, and ſome on each ſide; ſo that it's cover'd very ſhallow, tho' it lies deep within the Ground, where there is more Moiſture, than nearer to the Upper Level Surface; this cauſes the Seed to come up in dry Weather, and yet it's not in danger of being buried by a too great weight of Mould incumbent on it.

But take heed that no other Harrow come on it after 'tis Drill'd, for that might bury it. I never care to roll it at all, unleſs on account of the Barley, and then only in very dry Weather, with a light Roller, Length-ways of the Rows, immediately after 'tis Drill'd, or elſe ſtay Three Weeks afterwards, before it be roll'd, for fear of breaking off the Heads of the young St. Foin.

Be ſure to ſuffer no Cattle to come on the young St. Foin the firſt Winter (1), after the Corn is cut that grows amongſt it; their very Feet would injure it by treading the Ground hard, as well as their Mouths by cropping it: nor let any Sheep come at it, even in the following Summer and Winter.

One Acre of well drill'd St. Foin, conſidering the different Goodneſs of the Crops, and the Duration of it, is generally worth Two Acres of ſown St. Foin on the ſame Land, tho' the Expence of driling be Twenty times leſs than the Expence of ſowing it.

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(1) The Firſt Winter is the Time to lay on Manure, after the Crop of Corn is off; ſuch as *Peat-Aſhes*, or the like; becauſe there being no natural Graſs to partake of it, and the Plants being leſs, leſs will ſupply them; and becauſe when made ſtrong in their Youth, they will come to greater Perfection: But I never uſe any Manure on my St. Foin.

One of the Cauſes why St. Foin that is properly drill'd, laſteth longer (1) without Manure than the ſown, is, That the former neither over nor underſtocks the Paſture, and the latter commonly, if not always, doth one or the other, if not both; *viz.* Plants too thick in ſome Places, and too thin in others; either 'tis not ſingle, but in Bunches; or if it be ſingle 'tis too thin, it being next to impoſſible to have the Plants come true and regular, or nearly ſo, by ſowing at *random.* Plants too thick ſoon exhauſt the Paſture they reach, which never is more than a ſmall part of that below the Staple; when the Plants are too thin, the St. Foin cannot be ſaid to laſt at at all, becauſe it never is a Crop.

They who *ſow* Eight or Ten Buſhels of good Seed on an Acre in a good Seaſon, among their Corn, with Intent that by its Thickneſs it ſhould kill other Graſs, reduce their St. Foin almoſt to that poor Condition I have ſeen it in, where it grows naturally ſavage without ſowing or tillage, upon the *Calabrian* Hills near *Croto:* It makes there ſuch a deſpicable Appearance, that one would wonder how any Body ſhould have taken it in their Head to propagate ſo unpromiſing a Plant; and yet there has ſcarce been an Exotick brought to *England* in this or the laſt Age, capable of making a greater or more general Improvement, were it duly Cultivated.

Some think the *Cythiſus* would exceed it, but I am afraid the Labour of ſheering thoſe Shrubs by the Hands of *Engliſh* Servants, would coſt too much of its Profit.

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(1) I have now a great many ſingle St. Foin Plants in my Fields, that are near Thirty Years of Age, and yet ſeem as Young and Vigorous as ever; and yet it is common for Thick St Foin to wear out in Nine or Ten Years, and in poor Land much ſooner, if not often manured by *Soot, Peat-Aſh,* or *Coal-Aſh.*

Luſerne requiring more Culture, and being much more difficult to be fitted with a proper Soil, never can be ſo general as St. Foin.

Mr. *Laurence*, in his new Syſtem of *Agriculture*, pag. 400, is in Hopes of ſucceeding in his Project of Cultivating *Aſſa Fœtida* in *England* in lieu of St. Foin, and that it may be a greater Improvement than It or *Clover*. But I muſt beg leave to ſuſpect a little his Sincerity, when he delivers his Opinion, that Sheep fatted with *Silphium* or *Aſſa* would make Mutton of ſuch a wonderful pleaſant Taſte, as to be preferable and more delicate than that of *Bagſhot-Heath*; eſpecially when he relates, That one Drachm of it freſh from the Roots caſts a ſtronger ſmell than one Hundred Pound of it ſold by our Druggiſts; and how ‘ the whole Air of a Place is infected with ‘ its noiſom ſtench; and that *Ronodæus* thinks the ‘ *Indian* Palates are made of Braſs to endure it.

Upon the whole, this Reverend Gentleman's Meaning (for all Good Men mean well) ſeems to be for introducing *Silphium*, as an Improvement of another Kind than that of St. Foin, *viz.* That if he could prevail with the *Engliſh* to plant *Aſſa* all over the Iſland, as frequent as *St. Foin* and *Clover* are; ſo that by *Aſſuetude*, *Engliſh* Noſes might become as Brazen as thoſe of *Ronodæus*'s *Indians* (for thoſe of the *London* Goldfinders would be a Million of times too nice) then Mr. *Laurence*'s Project would be an extraordinary Improvement, and ſave the immenſe Charge of a Fleet to defend us; for tho' we had no other Guard but only this general ſtench of *Aſſa*, it would be as dangerous for any *European* Army to approach *England*, as for Serpents and Toads to invade *Ireland.* When this Contrivance ſucceeds, Mr. *Laurence* will deſerve no leſs of his Country, than St. *Patrick* did of his. But becauſe it may probably be a long Time before this Contrivance be ſo fully effected, as to bring St. Foin quite out of Faſhion, let us conſider in the *interim* the beſt Methods of ordering it for Hay and for Seed. The Profit of St. Foin Fields ariſing from either of theſe ways, is a great Advantage to their Owner, above that of natural Meadows; for if Meadow-Hay cannot have good Weather to be cut in its ſeaſon, it can ſerve for little other uſe than as Dung, and yet the Expence of mowing it, and carrying it off muſt not be omitted. But if there be not Weather to cut St. Foin before Bloſſoming, we may expect it 'till in Flower, or may ſtay till the Bloſſoms are off; and if it ſtill rain on, may ſtand for Seed, and turn to as good account as any of the former: So that it has four Chances to one of the Meadow.

The elevated but not mountainous Situation of the dry Land whereon St. Foin is moſtly planted, renders it ſo commodious for making of Hay, that it eſcapes there the Injury of Weather, when Hay in low Meadows is utterly ſpoil'd.

On the high Ground the Wind will dry more in an Hour, than on the Meadows in a whole Day. The Sun too has a more benign Influence above, and ſends off the Dew about Two Hours earlier in the Morning, and holds it up as much longer in the Evening. By theſe Advantages the St. Foin has the more time to dry, and is made with half the Expence of Meadow-Hay.

But before the manner of making it be deſcrib'd, the proper Time of Cutting it ought to be determin'd; and upon that depend the Degrees of its Excellence (beſides upon the Weather which is not in our Power) for tho' all ſorts of this Hay if well made be good, yet there is a vaſt Difference and Variety in them.

The ſeveral ſorts may be principally diſtinguiſh'd by the following Terms, *viz.* Firſt, The *Virgin*, Secondly,

condly, The *Bloſſom'd*, Thirdly, The *Full-Grown*, And Fourthly, The *Thraſh'd Hay*.

The Firſt of theſe is Beſt of all beyond Compariſon, and (except *Luſerne*) has not in the World its Equal, This muſt be cut before the Bloſſoms appear: For when it ſtands 'till full blown, the moſt ſpiritous, volatile, and nouriſhing parts of its Juices is ſpent on the next Generation; and this being done all at once, the Sap is much depauperated, and the St. Foin can never recover that Richneſs it had in its Virgin ſtate. And tho' when in Bloſſom it be *literally* in the Flower of its Age, 'tis really in the Declenſion of it. If it be ſaid, that what is not in the Stalk is gone into the Flower, 'tis a Miſtake, becauſe much the greateſt part of its Quinteſſence perſpires thence into the Atmoſphere.

And moreover that all Vegetables are in ſome degree weaken'd by the Action of continuing their Kind, may be inferr'd from thoſe Plants which will live ſeveral Years, if not ſuffer'd to bloſſom; but whenever they bloſſom, it cauſes their Death, tho' in the firſt Year of their Life. For in Plants (as Dr. *Willis* obſerves in Animals) Nature is more ſolicitous to continue the ſpecies, than for the Benefit of the Individual.

Part of a drill'd St. Foin Ground was cut the Beginning of *May*, before Bloſſoming (1), and from the time of cutting, until it was ſet up in Ricks, being about Ten Days, the Sun never ſhone upon it; but the Weather was miſty, at laſt it was forc'd to be carried together for fear of Rain, ſo Green that out of the largeſt Stalks one might wring milky

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(1) By Cutting before Bloſſoming is not meant before any one Bloſſom appears, for here and there a Bud will begin to open with a Red Colour long before the reſt; therefore, when we perceive only a very few Bloſſoms beginning to open, (perhaps but one of a thouſand) we regard them as none.

Juice; yet by making the Hay up in ſeveral little Ricks, and drawing up a great Chaff-Basket in the middle of each, its Firing was prevented; but it look'd of a dark Colour by Heating; and was the very beſt (1) Hay that ever I had.

The other Part of the Ground was afterwards cut in the prime of its Flower, and made into Hay by the Heat of the Sun, without Rain or Miſt: This came out of the Ricks at Winter with a much finer Colour, and as fine a ſmell as the Virgin-Hay, but did not come near it in fatting Sheep, or keeping Horſes fat at hard Work, without any Corn, as the Virgin-Hay did.

This ſuper-fine Hay cannot well be had of poor uncultivated (2) St. Foin; becauſe that may not be much above a Handful high, when 'tis in Condition to be ſo Cut, and would then make a very light Crop, and would be a great while e'er it ſprang up again: But the Rich will have Two or Three Tun to an Acre, and ſpring again immediately for a ſecond Crop; ſo that little or no Quantity would be loſt by ſo great an Improvement of its Quality. For Hoed St. Foin upon a poor Chalky Hill, cut at the ſame time with that uncultivated on a Rich Valley. does in dry Weather grow again without delay, when the Valley attends a Month or more for a Rain, to excite its vegetative Motion.

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(1) This Hay ſo cut before Bloſſoming, has kept a Team of working Stone-Horſes, round the Year fat without Corn, and when tried with Beans and Oats mixed with Chaff, refuſed it for this Hay. The ſame fatted ſome Sheep in the Winter, in a Pen with only It and Water; they thrived faſter than other Sheep at the ſame time fed with Peaſe and Oats. The Hay was weighed to them, and the clear Profit amounted to Four Pound *per* Tun. They made no Waſte, tho' the Stalks were of an extraordinary Bigneſs, they would break off ſhort, being very brittle: This grew on rich Ground in *Oxford-ſhire*.

(2) I reckon Manure of *Peat-Aſhes*, *Soot*, or the like, to be a Culture.

This Hay the Owner (if he be Wiſe) will not ſell at any common Price; but endeavour to have ſome of it every Year, if poſſible, for his own Uſe.

The ſecond ſort of St. Foin Hay is that cut in the Flower, and tho' much inferiour to the Virgin Hay, it far exceeds any other Kind, as yet commonly propagated in *England*; and if it be a full Crop, by good Culture, may amount to above Three Tun on an Acre. This is that St. Foin which is moſt commonly Made, and the larger it is, the more nouriſhing for Horſes. I have known Farmers, after full Experience, go Three Miles to fetch the largeſt ſtalky St. Foin, when they could have bought the ſmall, fine leafy ſort of it at Home, for the ſame Price by the Tun.

The next and laſt ſort of St. Foin that is cut only for Hay, is, the *Full-Grown*, the Bloſſoms being gone, or going off; this alſo is good Hay, tho' it fall ſhort by many degrees of the other Two ſorts: It makes a greater Crop than either of them, becauſe it grows to its full Bulk, and ſhrinks little in Drying.

This gives the Owner a Third Chance of having Weather to make good Hay, and ſpins out the Hay-ſeaſon 'till about *Midſummer*; and then in about a Fortnight, or Three Weeks after the Hay is finiſhed, the Seed is ripe. But Firſt of the Manner of making St. Foin Hay.

In a Day or Two after St. Foin is mow'd it will, in good Weather, be dry on the upper ſide; then turn the Swarths, not ſingly, but Two and Two together; for by thus turning them in Pairs, there is a double ſpace of Ground betwixt Pair and Pair, which needs but once Raking: Whereas if the Swarths were turn'd ſingly, that is, all the ſame way, ſuppoſe to the *Eaſt* or *Weſt*, then all the Ground will require to be Twice Raked; at leaſt more of it, than the other way.

As ſoon as both ſides of the Swarths are dry from Rain and Dew, make them up into little Cocks the ſame Day they are turn'd, if conveniently you can; for when 'tis in Cock, a leſs part of it will be expoſed to the Injuries of the Night, than when in Swarth.

Dew being of a Nitrous penetrating Nature, enters the Pores of thoſe Plants it reaches, and during the Night poſſeſſes the room from whence ſome part of the Juices is dry'd out; thus it intimately mixes with the remaining Sap, and when the Dew is again exhal'd, it carries up moſt of the vegetable Spirits along with it, which might have been there fix'd, had they not been taken away in that ſubtile Vehicle.

If St. Foin be ſpread very thin upon the Ground, and ſo remain for a Week in hot Weather, the Sun and Dew will exhauſt all its Juices, and leave it no more Vertue than is in Straw,

Therefore 'tis beſt to keep as much of our Hay as we can from being expoſed to the Dews, whilſt 'tis in making; and we have a better Opportunity of doing it in this, than in natural Hay; becauſe the bigger the Cocks are, the leſs Superficies (in proportion to the Quantity they contain) will be expoſed to the Dew; and St. Foin may be ſafely made in much larger Cocks than natural Hay of equal dryneſs can, which ſinking down cloſer excludes the Air ſo neceſſary for keeping it ſweet, that if the Weather prevents its being frequently mov'd and open'd, it will ferment, look yellow, and be ſpoil'd; againſt this Misfortune there is no Remedy, but to keep it in the leſſer Cocks, until thoroughly dry. St. Foin Cocks (twice as big as Cocks of natural Hay) by the leſs Flexibility of the Stalks admitting the Air, will remain longer without Fermenting.

This being able to endure more Days unmov'd, is alſo an Advantage upon another account, beſides the Weather; for tho' in other Countries, People are not prohibited uſing the neceſſary Labour on *all Days* for preſerving their Hay, even where the certainer Weather makes it leſs neceſſary than here, yet 'tis otherwiſe in *England*; where many a thouſand Load of natural Hay is ſpoil'd by that Prohibition for want of being open'd; and often by the Loſs of one Day's Work, the Farmer loſes his Charges and Year's Rent, which ſhews that to make Hay while the Sun ſhines, is an Exotick Proverb againſt *Engliſh* Laws, whereunto St. Foin being, in regard of Sundays and Holydays, more conformable, ought to be the Hay as proper to *England* as thoſe Laws are.

But to return to our Hay-makers. When the firſt Cocks have ſtood one Night, if nothing hinder, let them Double, Treble, or Quadruple the Cocks, according as all Circumſtances require, in this manner, *viz.* ſpread Two, Three, or more together in a freſh place; and after an Hour or Two, turn them, and make that Number up into One Cock; but when the weather is doubtful, let not the Cocks be thrown or ſpread, but enlarge them, by ſhaking ſeveral of them into One; and thus hollowing them to let in the Air, continue encreaſing their Bulk, and diminiſhing their Number daily, until they be ſufficiently dry to be carried to the Rick.

This I have found the moſt ſecure way, tho' it be ſomething longer in making, there is much leſs Danger than when a great Quantity of Hay is ſpread at once; for then a ſudden Shower will do more Harm to One Acre of that, than to Twenty Acres in Cock.

And the very beſt Hay I ever knew in *England*, was of St. Foin made without ever ſpreading, or the Sun's ſhining on it. This way, tho' it be longer e'er finiſh'd, is done with leſs Labour than the other.

Not only a little Rain, but even a Miſt will turn *Clover-Hay* Black; but St. Foin will not with any Weather turn Black until it be almoſt rotten, its Leaves being thinner than thoſe of *Clover*.

If St. Foin be laid up pretty green it will take no Damage, provided it be ſet in ſmall Round Ricks, with a large Basket drawn up the middle of each, to leave a Vent-Hole there, thro' which the ſuperfluous Moiſture of the Hay tranſpires.

As ſoon as its Heating is over, theſe Ricks ought to be thatch'd; and all St. Foin Ricks, that are made when the Hay is full dry'd in the Cocks, ought to be thatch'd immediately after making them.

That which is laid up moſt dry'd, will come out of the Rick of a Green Colour; that which has much heated in the Rick, will have a Brown Colour.

The Seed is a Fourth Chance the Owner has to make Profit of his St. Foin: But this, if the *Hoeing-Husbandry* were general, would not be vendible in great Quantities for planting; becauſe an ordinary Crop of an Acre, will produce Seed enough to Drill an Hundred Acres, which would not want re-planting in a long Time.

The other Uſe then of this Seed is for Provender, and it has been affirm'd by ſome who have made Trials of it, that Three Buſhels of good St. Foin Seed given to Horſes, will nouriſh them as much as Four Buſhels of Oats. When well order'd it is ſo *ſweet*, that moſt ſorts of Cattle are greedy of it. I never knew ſo much of it given to Hogs, as to make them become fat Bacon; but I have known Hogs made very good Pork with it, for an Experiment; and being valued at the beginning of their feeding, and the Pork by the Score when the Hogs were kill'd, which computed with the Quantity of Seed they eat, did not amount to near the Value of the ſame Seed ſold for ſowing; that being Three Shillings *per* Buſhel, and the Profit made by giving it to the Hogs was but Two Shillings a Buſhel.

The Goodneſs of the Seed, and of the Hay out of which it is Thraſh'd, depends very much upon the manner of Ordering them.

This Thraſh'd Hay, when not damag'd by wet Weather, has been found more nouriſhing to Horſes, than courſe Water-Meadow Hay; and when 'tis cut ſmall by an Engine is good Food for Cattle, and much better than Chaff of Corn.

It requires ſome Experience in it, to know the moſt proper Degree of Ripeneſs, at which the ſeeded St. Foin ought to be cut; for the Seed is never all ripe together, ſome Ears bloſſom before others; every Ear begins bloſſoming at the lower part of it, and ſo continues gradually to do upward for many Days; and before the Flower is gone off the Top, the Bottom of the Ear has almoſt fill'd the Seeds that grow there; ſo that if we ſhould defer cutting until the Top-ſeeds are quite ripe, the lower which are the beſt, would ſhed and be loſt.

The beſt Time to cut, is when the greateſt part of the Seed is well fill'd; the firſt blown ripe, and the laſt blown beginning to be full.

The natural Colour of the Kernel, which is the real Seed, is Grey or Blueiſh when ripe; and the Husk which contains the Seed is, when ripe, of a Browniſh Colour. Both Husk and Seed continue perfectly Green for ſome time after full grown; and if you open the Husk, the Seed will appear exactly like a green Peaſe when gather'd to boil, and will like that eaſily be ſplit into Two Parts. Yet St. Foin Seed in this green Plight will ripen after cutting,

ting, have as fine a Colour, and be as good in all reſpects, as that which was ripe before cutting: Some for want of obſerving this, have ſuffer'd their Seed to ſtand ſo long, till it was all ripe, and loſt in cutting.

St. Foin Seed ſhould not be cut in the Heat of the Day, whilſt the Sun ſhines out; for then much, even of the unripe Seed, will ſhed in Mowing: Therefore in very hot Weather, the Mowers ſhould begin to work very early in the Morning, or rather in the Night; and when they perceive the Seed to ſhatter, leave off, and reſt till towards the Evening.

After Cutting we muſt obſerve the ſame Rule as in Mowing it, *viz.* not to make this Hay whilſt the Sun ſhines.

Sometimes it may, if the Seed be pretty ripe, be Cock'd immediately after the Scyth; or if the Swarths muſt be turn'd, let it be done whilſt they are moiſt; not Two together, as in the other Hay aforemention'd. If the Swarths be turn'd with the Rake's Handle, 'tis beſt to raiſe up the Ear-ſides firſt, and let the Stub-ſide reſt on the Ground in turning; but if it be done by the Rake's Teeth, then let them take hold on the Stub-ſide, the Ears bearing on the Earth in turning over. But 'tis commonly Rain that occaſions the Swarths to want turning (1).

If it be Cock'd at all (2) the ſooner 'tis made into

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(1) If the Swarths be not very great, we never turn them at all; becauſe the Sun or Wind will quickly dry them.

(2) Sometimes when we deſign to Thraſh in the Field, we make no Cocks at all, and but only juſt ſeparate the Swarths in the Dew of the Morning, dividing them into Parts of about Two Foot in each Part. By this means the St. Foin is ſooner dry'd than when it lies thicker, as it muſt do if made into Cocks.

Cocks the better; becauſe if the Swarths be dry, much of the Seed will be loſt in ſeparating them, the Ears being entangled together. When moiſt, the Seed ſticks faſt to the Ear, but when dry, will drop out with the leaſt touch or ſhaking.

There are Two Ways of Thraſhing it, the one in the Field, the other in the Barn: The firſt cannot be done but in very fine Weather, and whilſt the Sun ſhines in the Heat of the Day; the beſt manner of this is, to have a large Sheet pegg'd down to the Ground, for two Men with their Flails to thraſh on: Two Perſons carry a ſmall Sheet by its Corners, and lay it down cloſe to a large Cock, and with two Sticks thruſt under the Bottom of it, gently turn it over, or lift it up upon the Sheet, and carry and throw it on the great Sheet to the Thraſhers; but when the Cocks are ſmall, they carry ſeveral at once, thrown upon the little Sheet carefully with Forks; thoſe which are near, they carry to the Thraſhers with the Forks only. As faſt as it is thraſh'd, one Perſon ſtands to take away the Hay, and lay it into an Heap: And ſometimes a Boy ſtands upon it, to make it into a ſmall Rick of about a Load. As often as the great Sheet is full, they riddle it through a large Sieve to ſeparate the Seed and Chaff from the broken ſtalks, and put it into Sacks to be carried into the Barn to be Winnowed.

Two Thraſhers will employ two of theſe little Sheets, and Four Perſons in bringing to them; and when the Cocks are thraſh'd, which ſtand at a conſiderable Diſtance all round them, they remove the Thraſhing-ſheet to another Place. There belong to a Set for one Thraſhing-ſheet ſeven or eight Perſons, but the Number of Sheets ſhould be according to the Quantity to be thus thraſh'd: The ſooner theſe thraſh'd Cocks are remov'd, and made into bigger

Ricks the better; and unleſs they be thatch'd, the Rain will run a great way into them, and ſpoil the Hay; but they may be thatch'd with the Hay it ſelf, if there be not Straw convenient for it.

But the chiefeſt Care yet remains, and that is to cure the Seed; if that be neglected, it will be of little or no Value; and the better it has eſcap'd the Wet in the Field, the ſooner its own Spirits will ſpoil it in the Barn or Granary. I have known it lie a Fortnight in Swarth, till the wet weather has turn'd the Husks quite black: This was thraſh'd in the Field, and immediately put into large Veſſels holding about twenty Buſhels each. It had by being often wet and often dry, been ſo exhauſted of its fiery Spirits, that it remain'd cool in the Veſſels, without ever fermenting in the leaſt, till the next Spring, and then it grew as well as ever any did that was planted.

But of Seed thraſh'd in the Field without ever being wetted, if it be immediately Winnow'd, and a ſingle Buſhel laid in a Heap, or put into a Sack, it will in few Days ferment to ſuch a degree, that the greateſt part of it will loſe its vegetative Quality: The larger the Heap the worſe; during the Fermentation it will be very Hot and ſmell ſour.

Many to prevent this ſpread it upon a Malt-Floor, turning it often; or when the Quantity is ſmall, upon a Barn-Floor; but ſtill I find that this way a great deal of it is ſpoil'd, for it will heat tho' it be ſpread but an handful thick, and they never ſpread it thinner; beſides they may miſs ſome Hours of the right times of turning it, for it muſt be done very often; it ſhould be ſtirr'd in the Night as well as the Day, until the Heating be over; and yet do what they can, it never will keep its Colour ſo bright as that which is well Houſed, well Dry'd, and Thraſh'd in the Winter: For in the Barn the Stalks keep it hollow; there are few Ears or Seeds that touch one another, and the Spirits have room to fly off by degrees, the Air entring to receive them.

The only way I have found to imitate and equal this, is to Winnow it from the Sheet, then lay a Layer of Wheat-ſtraw (or if that be wanting, of very dry thraſh'd Hay) then ſpread thereon a thin Layer of Seed, and thus *Stratum ſuper Stratum*, ſix or ſeven Foot high, and as much in Breadth; then begin another Stack, let there be Straw enough, and do not tread on the Stacks; by this means the Seed mixing with the Straw, will be kept cool, and come out in the Spring with as green a Colour as when it was put in, and not One Seed of a Thouſand will fail to grow when planted. A little Barn-Room will contain a great Quantity in this manner.

I have had above one Hundred Quarters of clean Seed thus manag'd in one Bay of a ſmall Barn. We do not ſtay to winnow it clean before we lay it up in the Straw, but only paſs it thorough a large Sive, and with the Van blow out the Chaff, and winnow it clean in the Spring.

This Field-thraſhing requires extraordinary fine Sun-ſhiny Weather, which ſome Summers do not afford at the Seaſon, for thraſhing a great Quantity of it; for 'tis but a ſmall part of the Day in which the Seed can be thraſh'd clean out. They who have a ſmall Quantity of it, do carry it into a Barn early in the Morning, or even in the Night, whilſt the Dew is on it, for then the Seed ſticks faſt to the Ear: As it dries they thraſh it out, and if they cure it well, have thus ſometimes good Seed, but generally the Hay is ſpoil'd.

There is one Method of ſaving all the Seed good, and the Hay too, by carrying it unthraſh'd to the Barn, or Rick it in a particular manner, tho' it be a great Quantity, more than can preſently be thraſh'd;

but muſt be laid up in Mows or Ricks as Corn is. Then if it be carried in, in the Dews or Damp, the Hay is ſure to be ſpoil'd, if not both Hay and Seed: When 'tis taken up dry, the Seed comes out with a Touch, and the greateſt part is loſt in pitching up the Cocks, Binding, and Jolting in carrying Home.

To avoid this Dilemma, a Perſon who happen'd to have a great Crop of Seed on One Hundred and Fifty Acres together (and being by Weather delay'd 'till Wheat-Harveſt came on, ſo that moſt Labourers went to Reaping) was forc'd to a Contrivance of getting it in as follows, *viz.* Three Waggons had each a Board with an hole in, fix'd Croſs the Middle of each Waggon by Iron Pins, to the Top of the Rades or Sides: There was a Crane which a Man could lift, and ſet into the Hole in the Board, and having an Iron-Gudgeon at the bottom, which went into a Socket in the Bottom of the Waggon, would turn quite round: The Poſt of the Crane was Ten Foot Four Inches long, its Arm Four Foot Eight Inches long Brac'd; having a Treble Pulley at the End of it, and another to anſwer it with a Hook.

About Forty Sheets were provided, capable of of holding each One Hundred and Fifty, or Two Hundred Pounds Weight of it; theſe had Knots or Buttons at the Corners and Middles, made by Sewing up a little Hay in theſe Knots, as big as Apples, into part of the Sheet; for if any Buckle or other thing be ſew'd to a Sheet plain, it will tear the Sheet. Half theſe Buttons have Strings ty'd to them, the Sheets are ſpread among the Cocks, fill'd by two, and ty'd up by two other Perſons; there is alſo a light Fir Ladder, wide at Bottom, the Top of it faſten'd by a piece of Cord to the Brace of the Crane, they hitch the Hook of the lower Pulley to a fill'd Sheet, and by a little Horſe at the End of the Pulley-Rope, draw it up ſliding on the Ladder; 'tis up in a Moment: Then the Man who is below, hitches the Crook of the Pulley to the lower Round of the Ladder, and the Loader above pulls up the Ladder from the Ground, 'till the Waggon comes to another Sheet. The Waggons are lengthen'd by Cart-Ladders before and behind, for the more eaſy placing of the Sheets. When about Twelve or Fifteen of them are loaded, they have a Rope fix'd to the Fore-part of each Waggon, which they bring over the Top of all the loaded Sheets, and wreſt it at the Tail, to hold on the Sheets faſt from falling off with jolting. Then the Loader pulls out the Crane, and puts it into the next Waggon in the ſame Manner. One Waggon is Loading whilſt another is Emptying in the Barn, by Treble Pulleys likewiſe; becauſe 'tis inconvenient to take it out of the Sheets by Prongs, but the Pulleys will eaſily draw off Two or Three Sheets together. One Waggon is always going to the Field, or coming Home. This Contrivance makes more Expedition than one would imagine: Three Loads have been loaded and ſent off in the ſame time this way, that One Load of Hay has been Loading, Binding and Raking off the Outſides of it, in the next Ground in the common way.

I will not relate the manner of making a Rick of this Seed in its Hay, of monſtrous Dimenſions, by a ſort of Maſt-Pole Forty-four Foot high, with a Ten Foot Crane at the Top, which made the ſame Expedition; becauſe I think, that where ſuch a Quantity is, Dutch Barns with moving Roofs are better. Such a Rick is troubleſome to Thatch, and the Wind has more Power to blow the Thatch off ſo high in the Air, than if it were lower. Neither would I adviſe any one to reſerve much more St. Foin for Thraſhing, than his Barn will contain; becauſe tho' ſometimes it brings the greateſt Profit by Thraſhing, yet ſome Years 'tis apt to be Blighted.

I have been told by my Neighbour, that he had a Crop of Five Quarters of St. Foin Seed on an Acre; but the moſt Profit that ever I took notice of was on half an Acre, which was drill'd very Thin, and had no Crop of Corn with it; by which Advantage it produc'd a good Crop of Seed the next Year after 'twas planted, and the Third Year this half Acre produc'd (as was try'd by a Wager) within a triffle of Two Quarters of Seed, which was ſold for Two Pounds and Ten Shillings: The Thraſh'd Hay of it was ſold in the Place for One Pound, and Two Quarters of Chaff ſold for Twelve Shillings; in all Four Pounds and Two Shillings. There was alſo a very good Aftermath, which was worth the charges of cutting and Thraſhing: So that the clear Profit of the One Year of this half Acre of Ground, amounted to Four Pounds Two Shillings: And it was remarkable, that at the ſame time the reſt of the ſame Field, being in all Ten Acres, had a Crop of Barley ſown on Three plowings, which (the Summer being dry) was offer'd to be ſold at One Pound *per* Acre.

I believe the greateſt part of the St. Foin that is ſown, is ſpoil'd by being indiſcreetly fed by Sheep (1); which Damage is occaſion'd merely by ſuffering them to continue feeding it too long at a time, eſpecially in the Spring, for then the Sap moves quick, and muſt be depurated by the Leaves; and as the Sun's nearer approach accelerates the Motion or Ferment of the Juices, more *Pabulum* is receiv'd by the Roots;

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(1) I never ſuffer Sheep to come upon St. Foin, except betwixt Mowing-time and *All-Saints*. And there is ſo much danger of ſpoiling St. Foin by the Fraud of Shepherds, that I knew a Gentleman that bound his Tenant never to ſuffer any Sheep to come thereon; and by this means his St. Foin continued in Perfection much longer than is uſual, where St. Foin is ſuffer'd to be fed by Sheep.

but for want of Leaves to diſcharge the Recrements, and enliven the Sap with Nitroaerious Particles (the Sheep devouring the Buds continually as faſt as they appear) the St. Foin's vital Flame (if I may ſo call it) is extinguiſh'd; the Circulation ceaſing, the Sap ſtagnates, and then it ends in Corruption (1). But let the Sheep eat it never ſo low, in a ſhort time, without continuing thereon, or cropping the next Buds which ſucceed thoſe they have eaten, the Plants will recover and grow again as vigorouſly as ever; and if with a Spade, in the Winter, you cut off the St. Foin Heads an Handful deep, and take them away, together with their upper Earth, the Wound in the remaining Root will heal, and ſend out more Heads as good as thoſe cut off, if thoſe ſecond Heads be preſerv'd from Cattle, until they attain to a Bigneſs competent to bear Leaves ſufficient for the uſe of the reviving Plants: Nay, I have ſeen Plants of St. Foin cut off in the Winter a Foot deep, and the Earth of that Depth taken away, and the remaining Root recover'd and grew to an extraordinary Bigneſs, but this was preſerv'd from Cattle at firſt.

I eſteem St. Foin to be much more profitable than *Clover*, becauſe St. Foin is never known to do any perceivable Damage to the Corn amongſt which 'tis planted, but *Clover* often ſpoils a Crop of Barley; and I have known that the Crop of Barley has been valu'd to have ſuffer'd Four Pounds *per* Acre Damage, by a Crop of *Broad Clover*'s growing in it in a wet Summer: In a dry Summer both ſorts of *Clover* are apt to miſs growing, and if it does grow, and the next Summer (wherein it ought to be a Crop) prove very dry, it fails on moſt ſorts of Land, tho' it was vigorous enough to ſpoil the Barley the Year it was ſown; at beſt 'tis of but very ſhort Duration, and therefore is not to be depended on by the Farmer, for maintaining his Cattle, which the *Broad Clover* will alſo kill, ſometimes by cauſing them to ſwell, unleſs great Care be taken to prevent it. The *Broad Clover* is eſteem'd a foul Feed for Horſes. The *Hop-Clover* is gone out of the Ground ſooner than thr *Broad Clover*; I never knew it cut more than Once: Indeed Cattle are never ſwoll'n by feeding on it; but then it affords but very little Feeding for them, except the Land whereon it grows be very Rich.

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(1) Natural Graſs is not kill'd by conſtant feeding, becauſe no ſort of Cattle can bite it ſo low as to deprive it of all its Leaves; and 'tis like Eels, more tenacious of Life than the reſt of its *Genus*, and will ſend out Leaves from the very Roots when reverſed, as is too often ſeen where Turffy Land is plow'd up in large Furrows.

St. Foin is obſerv'd to enrich whatever Ground 'tis planted on, tho' a Crop be taken off it yearly.

Poor *Slate* Land (1), when it has borne *ſown* St. Foin for ſix or ſeven Years, being plow'd up and well till'd, produces Three Crops of Corn, and then they ſow it with St. Foin again.

Rich Arable Land was planted with it, and mow'd annually with very great Crops ('twas drill'd in Nine Inch Rows, with ſix Gallons of Seed to an Acre; One Crop of it was ſold at four Pounds *per* Acre) this after about ſeven Years, and in full Perfection, was plow'd up by a Tenant, and continu'd for many Years after ſo Rich, that inſtead of dunging or fallowing it for Wheat, they were forc'd to ſow that upon Barley-ſtubble, and to feed the Wheat with Sheep in the Spring, to prevent its being too Luxuriant.

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(1) The Poverty of this ſort of Land, lying upon Slate or Stone, generally proceeds from the Thinneſs of it, and if it were Thicker it would be good Land; much of this Earth being diſperſed among the Cranies or Interſtices of the Slate and Stone to a great Depth, is reach'd by the Tap-Roots of the St. Foin, but cannot be reach'd by the Roots of Corn; and therefore when conſtantly kept in Tillage is of ſmall Value, upon which account ſuch Land is greatly improveable by St. Foin, even when ſown in the common manner.

But 'tis to be noted, that the Land muſt be well till'd at the *Breaking* up of old St. Foin, or elſe the firſt Crops of Corn may be expected to fail: For I knew a Tenant, who the laſt Year of his Term, plow'd up a Field of St. Foin, that would have yielded him Three Pound *per* Acre; but thinking to make more Profit of it by Corn, he ſow'd it with White Oats upon Once plowing, and it proving a dry Summer, he loſt his Plowing and Seed; for he had no Crop of Oats, and was forced to leave the Land as a Fallow to his Succeſſor.

Many more Inſtances there are of this Failure of the Crop of Corn after St. Foin has been broke up, and not well till'd.

When St. Foin is grown old and worn out, as 'tis ſaid to be when the artificial Paſture is gone, and the natural Paſture is become inſufficient for the Number of Plants that are on it to be maintained, and is ſo poor that it produces no profitable Crop, ſo that the Ground is thought proper to be plow'd up and ſown with Corn, in order to be replanted (1); the moſt effectual way to bring it into Tilth ſpeedily, is to plow it up in the Winter, with a Four-Coulter'd Plow, and make it fit for Turneps by the following Seaſon; and if the Turneps be well Hoed, and eſpecially if ſpent by Sheep on the Ground, 'twill be in excellent Order to be ſown with Barley the following Spring, and then it may be drill'd with St. Foin amongſt the Barley.

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(1) Or if you perceive that there is a competent Number of Plants *alive* and tolerably *ſingle*; be they never ſo poor, you may recover them to a flouriſhing Condition in the following manner without replanting: Pulverize the whole Field in Intervals of about Three Foot each, leaving betwixt every Two of them Four Foot Breadth of Ground unplow'd, when the Turf of theſe Intervals being cut by the Four-Coulter'd Plow is perfectly rotten: One Furrow made by any ſort of Plow will Hoe one of theſe Intervals, by changing the whole Surface of it. The poorer the Land is the more Hoeings will be required, and the oftner 'tis Hoed, with proper Intermiſſions the

To return to the Benefit Land receives by having been planted ſome Years with St. Foin. All the Experienc'd know, that Land is enrich'd by it, but they do not agree upon the Reaſon why.

They agree as to the Ὅτι, but not the Διότι.

Some are of Opinion, 'tis becauſe the St. Foin takes a different ſort of Nouriſhment to that of Corn: But that I think is diſprov'd in Chapter of *Change of Species*, where 'tis ſhewn that all Plants in the ſame Soil muſt take the ſame Food.

Mr. *Kirkham* thinks St. Foin has no Collateral or Horizontal Roots in the upper part of the Ground where the Plow tills for Corn, and therefore has no Nouriſhment from that part of the Soil which feeds the Corn. This would be a very good Account for it, were it not utterly contrary to Matter of Fact, as every one may ſee.

But ſo far it is right, that Large (1) St. Foin draws

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the firſt Year, the ſtronger the St. Foin will become, and the more Years it will continue good, without a Repetition of Hoeing.

The Expence of this cannot be great; becauſe the Plow in Hoeing an Acre in this manner Nine Times, Travels no farther than it muſt to plow an Acre *Once* in the common manner.

I need not tell the Owner that the Earth of theſe Intervals muſt be made level before the St. Foin can be mowed.

(1) For large St. Foin being ſingle has large Roots and very long, which probably deſcend Twenty Foot deep: Now if we allow Four or Five Inches the Depth of the Staple, to afford a Supply equal to Two Foot below it, taking the lower nineteen

draws the greateſt part of its Nouriſhment from below the reach of the Plow; and what part it does receive from the Staple is over-balanc'd by the ſecond Crop or After-Leaſe, being ſpent by Cattle on the Ground; different from Corn, which is very near wholly maintain'd by the Plow'd-part of the Earth, and is all carry'd off.

For tho' the under *Stratum* of Earth be much poorer than the upper, yet that never having been drain'd by any ſort of Vegetables, muſt afford conſiderable Nouriſhment to the firſt that comes there.

And beſides in ſuch Land whoſe Poverty proceeds from the Rain's carrying its Riches too quickly down through the upper *Stratum*, the under *Stratum* muſt be the richer (1) for receiving what the upper *Stratum* lets paſs Unarreſted.

'Tis well known that many Eſtates have been much improv'd by St. Foin; therefore there is no occaſion to mention Particulars. Only I will take notice that the Firſt in *England* was one of about One Hundred and Forty Pounds *per Annum*, ſown with St. Foin, and ſold for Fourteen Thouſand Pounds; and as I hear continues, by the ſame Improvement, ſtill of the ſame Value. This is I ſuppoſe the ſame that Mr. *Kirkham* mentions in *Oxfordſhire*.

Another Farm of Ten Pounds *per Annum* Rent, which whilſt in Arable (2), was like to have Undone

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teen Foot ſeven Inches together, upon this Computation, the Part below the Staple gives the St. Foin about Nine parts in Ten of its Suſtenance.

(1) In light poor Land the Water carrying ſome impregnated Earth along with it down lower than it does in ſtrong Land, that is more tenacious of ſuch impregnated Particles, the under *Strata* of ſtrong Land are likely to be poorer than thoſe of light Land.

(2) Theſe Eſtates conſiſted of Thin Slatey Land; which, before

done the Tenant, but being all planted with St. Foin, by the Owner was let at One Hundred and Ten Pounds *per Annum*, and prov'd a good Bargain.

If it ſhou'd be ask'd, Why St. Foin is an Improvement ſo much greater in *England*, than in other Countries? It might be anſwer'd by ſhewing the Reaſon why *Engliſh* Arable is of ſo much leſs Value than Foreign, where the Land is of equal Goodneſs, and the Corn produc'd of equal Price.

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fore it was planted with St. Foin, was valued at two Shillings *per* Acre, and ſome part of it at One Shilling *per* Acre, (as I have been inform'd) and yet Oxen are well fatted by the St. Foin it produces.

CHAP. XV. *Of LUSERNE.*

LA *Luſerne* is that famous *Herba Medica* ſo much Extoll'd by the Ancients.

The high Eſteem they had of its Uſe appears by the extraordinary Pains they beſtow'd on its Culture.

Its Leaves reſemble thoſe of *Trefoil*; it bears a Blue Bloſſom very like to double Violets, leaving a Pod like a Screw, which contains the Seeds about the Bigneſs of *Broad Clover*, tho' longer and more of the Kidney Shape.

The Stalks grow more perpendicular than any of the other Artificial Graſſes that I know, ſlender, full of Knots and Leaves; 'tis of very near an equal Bigneſs from Bottom to Top: When cut, if vigorous, the Stalks will ſpring out again from the Stubs, immediately below where the Scythe parted them, which makes them the ſooner ready for another Mowing; an Advantage which no other Graſs has.

It has a Tap-Root that penetrates deeper into the Bowels of the Earth than any other Vegetable She produces.

Tho' one *Luſerne* Root be much more taper than another towards the upper part of it, 'tis ſometimes ſeen that a ſingle Hoed Plant of it has many of theſe perpendicular Roots, ſome of them ſpringing out from the very Branches of its Crown.

Its Roots are abundantly longer than the Roots of *St. Foin*: I have One that meaſures very near two Inches Diameter; thoſe which are higher than the Ground have a Bark like a Tree. Upon this account, and by its Stalks ſpringing again juſt below the place where cut off, and by the woody Hardneſs of its Stalks, when they ſtand too long without cutting, it ſeems that *Luſerne* is of a Nature nearly approaching to that of a Shrub.

Luſerne is the only Hay in the World that can pretend to Excel or Equal *St. Foin*. I have known Inſtances of the Pinguifying Virtue of this *Medica Hay*, that come up to the higheſt Encomiums given it by the Romans; which being to the Vulgar incredible, I forbear to relate, but leave to be confirm'd by the Experience of others, when it becomes frequent in *England*.

Luſerne in Graſs is much ſweeter than *St. Foin*, or any other Artificial or Natural Graſs. This when Ho'd may be given to Cattle cut green, for Six Months; but then care muſt be taken to prevent their Swelling by its Luſciouſneſs, and not to give them too much at Once, until they be accuſtom'd to it.

The Quantities of *Luſerne* Seed annually Imported, and ſown without Succeſs, not diſcouraging People from continuing its Importation, ſhews there is more need of a ſucceſsful way of Planting, than Recommending it in *England*.

I ſhall take notice of ſome of the Reaſons why I conclude there is no Hope of making any Improvement by planting it in *England*, in any manner practis'd by the Ancients or Moderns.

I wonder how any one ſhould attempt to plant it here, who has ſeen in *Columella* and other Authors, the Deſcription of the Manner the Old *Romans* planted it in. They choſe out the very beſt Land, that was both *Pinguis* and *Putris*; they dung'd and till'd it to the greateſt Perfection, and laid it out in Beds, as we do for Onions or Aſparagus; they ſow'd it very thick, for that miſerable Reaſon of enabling it by its Thickneſs the better to kill the Graſs. The Beds being Harrow'd very fine before ſowing, which was in the End of *April*, the Seed required to be ſpeedily cover'd, leſt the Sun's Heat ſhould ſpoil it. But with what Inſtrument muſt it be cover'd? For after ſowing, the Place muſt not be touch'd with Iron. *At Medica obruitur non Aratro, ſed Ligneis Raſtellis. Medica* Seed is cover'd, not with the Plow, but with little (or rather light wooden Harrows. Two Days Work (of a Team) were ſpent on this Harrowing of One Acre. Some time after it came up, they ſcratch'd it again and again with the ſame wooden Inſtruments, this was call'd Sarrition; then by Runcation they weeded it over and over, *Ne alterius generis herba invalidam Medicam perimat.* Leſt other Graſs ſhould kill it whilſt it was weak. The firſt Crop they let ſtand till ſome of the Seed ſhatter'd, to fill the Ground yet fuller of Plants: After that they might cut it as young as they pleas'd; but muſt be ſure to water it often after cutting. Then after a few Days when it began to ſpring, yet they repeated their Runcation, and ſo continuing to Weed out all manner of Graſs for the firſt two or three Years, it uſed to bring four or ſix Crops a Year, and laſt Ten Years.

Engliſh Gardeners make Forty Pound of an Acre of Aſparagus, or Cabbage Plants, with half the Labour and Expence that was beſtow'd on an Acre of *Roman Medica*.

We know not the Price Hay and Graſs were at in *Italy*, whilſt the *Roman* Empire was in its Glory, and *Rome* then the Metropolis of the World, drew the Richeſt of all Parts thither; its Price muſt be then very high.

And the *Romans* had not only Servants, but Plenty of Slaves, for whom they had ſcarce ſufficient Employment; this might leſſen the Expence of this tedious Method of Planting, and Ordering the *Medica*. But when the *Romans* were brought down to the Level of other Nations, and in danger of being Slaves, inſtead of having them; and the Lands of *Italy* came to be Cultivated by *Italian* Hands only, they found ſomething elſe more neceſſary to employ them in, than the Sarritions, Runcations, and Rigations of the *Medica*. Their Labour being beſtow'd in getting Bread for themſelves, they ſubſtituted other Artificial Graſſes of more eaſy Culture, in the Room of *Medica*, for the Food of their Cattle. They were ſo bigotted to all the Superſtitions of their Anceſtors, that they were content to loſe the uſe of that moſt beneficial Plant, rather than attempt to Cultivate it by a new, tho' more rational Method, when they were become unable any longer to continue it by the old.

Thus, as I take it, Superſtition has chaſed *Medica* from the *Roman* Territories, and ſo little of it is planted there, that beyond the *Alps*, I could not find one whole Acre of it.

Luſerne makes a great Improvement in the *South* of *France*; there when their low ſandy Land is well prepar'd, and very clean, they ſow it alone, in *March* and at *Michaelmas* as we do *Clover*: Their ſowing it at thoſe Seaſons is of a double Advantage; Firſt it ſaves the Labour of watering it, which would be impracticable for ſo many Thouſand Acres, as are there planted. Secondly, Thoſe Seaſons being much moiſter than That wherein the *Romans* ſow'd it, the Grub has Opportunity of eating more of it at its firſt coming up; and often the Froſt kills ſome of it. By theſe Advantages the Ground is leſs over-ſtock'd.

The Summers there are much drier than in *Italy*, ſo that the Sun ſcorches up the Natural Graſs, and ſuffers it not to come to a Turf 'till after ſome Years; and therefore has leſs need of Weeding.

But as that Natural Graſs encreaſes, the Crops of *Luſerne* are proportionably diminiſh'd: And though *Luſerne* is ſaid to laſt Ten or Twelve Years, yet it is in Perfection only for a very few Years. Whilſt it is at beſt on their richeſt Land, and in a kind Summer, they have at ſeven Crops Ten Tuns to an Acre, as I have computed them from the Relation of ſome of the Inhabitants of *Pezenas*. This was extraordinary, for I obſerv'd that moſt of their common Crops made a very Thin Swarth.

When the Ground begins to be Turffy and Hard, many of the *Luſerne* Plants Die, and the reſt ſend up very few Stalks: The People know this is the Deſtruction of it, and therefore I have ſeen ſome of them in that Caſe, Half Plow it, thinking thereby to deſtroy the Turf; this does for a time much ſtrengthen the *Luſerne* Plants, but it ſo much ſtrengthens the Graſs alſo, that the Turf grows the ſtronger, and then there is no Remedy but to plow it up, make the Ground clean, and replant it.

In more Northern Climates where it rains oftener, the Ground ſooner becomes hard; and in the Land otherwiſe moſt proper for *Luſerne*, the Graſs grows infinitely faſter, and will be as ſtrong a Turf in two

Years, as in the hot Countries in Ten. Upon this account about *Paris*, even near the Walls, they plow up *Luſerne*, and ſow *St. Foin* in its room, becauſe that endures Graſs and hard Ground better, tho' it brings but one Crop a Year, or two at moſt.

And in many Places in *Franch Conte* and *Switzerland*, I have ſeen *Luſerne* in the Corners of Vineyards, not above two or three Perches together, which they will at any Expence have to Cure their Horſes when ſick; ſince they cannot obtain, by their Culture, Quantities ſufficient to maintain them as their ordinary Food, there being too much Rain, and too little of the Sun's violent Heat, to prevent the ſpeedy Encreaſe of Graſs amongſt it.

How then can we expect Succeſs in ſowing it in *England*, where Rains are yet more frequent, and the Sun is weaker? 'Tis not One Year in Ten that the Natural Graſs is here ſcorch'd up. In our Rich Land the Graſs comes to a Turf very ſoon, and Poor Land will not by the common Sowing bring *Luſerne* to any perfection, tho' no Graſs ſhould annoy it.

I have here ſeen Part of a Meadow Breaſt-plow'd, and when the Turf was dead, Dug up and Planted as a Garden; after it had been Drill'd with Carrots, Ho'd and made in all appearance perfectly clean, it was Sown with *Luſerne*, which came up and flouriſh'd very well the firſt Year, and indifferently the ſecond; but after that, the Graſs came, and the *Luſerne* grew faint, and in three or four Years time there was no more left, but juſt to ſhew by here and there a ſingle poor Stalk, that there had been *Luſerne* ſown, except One Plant of it, which was cleanſed of Graſs the third Year; and this recover'd and ſent up abundance of Stalks for two Years after it; and then the Graſs returning, that Plant dwindled again.

I have often try'd it in the richeſt part of my Garden, and conſtantly find, that however vigorouſly it grows at the firſt, yet it ſoon declines, when the Graſs appears amongſt it, which is always the ſooner, by how much the Soil (in *England*) is richer, unleſs the Spade or Hoe prevent it.

Here has been alſo many Fields of a poorer whitiſh Soil ſown with it, which are not very ſubject to be over-run with Graſs, as the rich Land is; and tho' theſe were ſo well till'd as ſcarce any Graſs appear'd, during the many Years the *Luſerne* liv'd therein, yet it never grew to any Perfection here neither; nor was there any one Crop worth much more than the Cutting, it was always ſo poor, thin, and ſhort. And by what Intelligence I can get, all Experience proves, that every Soil in this Iſland is too rich, too poor, or too cold for the *Luſerne* Improvement by the common Husbandry.

I believe every one will be confirm'd in this, who ſhall upon full enquiry find, that amongſt the great Quantities which have been ſown in this Kingdom in that manner, never any of it was known to continue good and flouriſhing Three Years. And that on the contrary, never any One Plant of it in any Warm Soil, cultivated by the Hoeing Manner, was known to fail here, or in any other Country, as long as the Hoeing (or Digging about it, which is equivalent) was continued to it with proper Repetitions.

A Multitude of ſuch Hoed Plants have I known, and are now to be ſeen in both Poor and Rich Lands; therefore it ſeems poſſible, that Thouſands of *Engliſh* Acres may be capable by the Hoeing Culture, to produce Crops of *Luſerne* every Year for an Age. For as the greater Moiſture, and leſs intenſe Heat of this Climate, are upon the Accounts mention'd Injurious to *Luſerne*, yet this is only to ſuch as is ſown and cultivated in the common manner, becauſe our Climate upon the very ſame Accounts is very Advantageous to Hoed *Luſerne*.

In Hot Countries, when the Summer is drier than ordinary, the Sun ſo ſcorches it, that they have fewer and much poorer Crops, than in moiſter Summers, *viz.* only four or five inſtead of ſix or ſeven; but in the drieſt Summer I ever knew in *England*, Hoed *Luſerne* yielded the moſt Crops.

Our Summer Days are longer, have more of the Sun's Warmth, and leſs of his Fiery Heat; he cheriſhes but never burns *Luſerne*, or any other Hoed long Tap-Rooted Plant in *England*.

The well Hoed Earth being open, receives and retains the Dews; the benign Solar Influence is ſufficient to put them in Motion, but not to exhale them from thence. The Hoe prevents the Turf, which would otherwiſe by its Blades or Roots intercept, and return back the Dews into the Atmoſphere, with the Aſſiſtance of a moderate Heat. So that this Husbandry ſecures *Luſerne* from the Injury of a wet Summer, and alſo cauſes the Rain-Water to ſink down more ſpeedily, and diſperſe its Riches all the way of its paſſage, otherwiſe the Water would be more apt to ſtand on the Surface, chill the Earth, and keep off the Sun and Air from drying it: For when the Surface is dry and open, *Luſerne* will bear a very great degree of Heat, or grow with a mean one: I have ſeen this Hoed *Luſerne*, in a ſheltry Place of my Garden, ſo much grown in a mild Winter, as to be meaſur'd Fourteen Inches and a Half high at *Chriſtmas*; and a very large ſingle Plant of it, which had not been Hoed for Two Years before, was laid bare by Digging out the Earth all round it a Foot deep, to obſerve the manner of its Tap-Root; and then the Earth was thrown in again, and the

Hole fill'd up. This was on the Twenty-ſeventh of *September*; upon this mellowing of the Soil about it, it ſent out more Stalks in *October*, than it had done in the whole Summer before; they grew very vigorouſly, until a great Snow fell in *December*, which alſo preſerv'd the Verdure of them, 'till that was melted away, and a Black Froſt came after it, and killed thoſe Stalks. It's probable this Plant ſent out immediately new fibrous Horizontal Roots, which did grow apace to extract the Nouriſhment from this new made Paſture, in proportion to the quick growth of the Stalks, which in Summer have been meaſur'd, and found to grow in Height Three Inches and a Half in a Night and Day; this being almoſt One Inch in ſix Hours.

And it has been my Obſervation, that this Plant in Hot and Cold Countries, Thrives both with a much greater, or leſs degree of Heat and Moiſture when it is Hoed; for if it has Plenty of Nouriſhment, which Hoeing always gives it, a very little Heat above, and the Moiſture alone (which is never wanting to the deep Tap-Root) ſuffice, and that Plenty of Food enables it the better to endure the Extremes of either Heat or Cold.

We need not much apprehend the Danger of *Engliſh* Winters; for *Luſerne* will endure thoſe which are more Rigorous. In the Principality of *Neufchâtel* the Winters are ſo ſevere, as to kill all the Roſemary left abroad, yet *Luſerne* ſurvives them there; this proves it more hardy than Roſemary, which is planted for Hedges in *England*, and here is ſcarce Twice in an Age a Froſt able to kill it.

I have one ſingle *Luſerne* Plant in a poor Arable Field, that has ſtood the Teſt of Two and twenty Winters, beſides the Feeding of Sheep at all Seaſons, and remains yet ſtrong as ever. What Quantity of Hay this Plant yearly produces, cannot be known, becauſe at thoſe times that Cattle are kept from it, the Hares conſtantly crop it, being ſweeter than any other Graſs.

But this happens to be fortunately ſituate, where 'tis not altogether deſtitute of the Benefit of Hoeing. 'Tis in an Angle where every time the Field is Till'd, the Plow goes over it in turning from the Furrows of One Land and One Head-Land, but it is after the Plow is lifted out of the Ground, and turn'd up on one ſide, ſo that the Share only breaks the Turf very ſmall all round it, without plowing up the Plant: yet it has eſcap'd it ſo narrowly, that the Fin of the Plow-ſhare has ſplit it into Four Parts, Three of which remain and grow never the worſe, but the Fourth is torn off, and the Wound heal'd up.

By the extreme hard Winter that happen'd about the Year 1708, or 1709, ſome of the *Luſerne* in *Languedoc* was kill'd; yet this was no Argument of its Tenderneſs, but rather the contrary; becauſe then all the Olive Trees and Walnut Trees were there kill'd, tho' the greateſt part of the *Luſerne* eſcaped unhurt. And I did not hear One Walnut-Tree was kill'd that Winter in *England*. Perhaps thoſe in *France* having been accuſtom'd to much Hotter Summers, were unable to endure the Rigor of the ſame Winter, that could do no harm to the ſame Species in *England*, where our Winters do not ſeem to exceed ſome of theirs in Cold, ſo much as their Summers do ours in Heat. And ſince the Extremes are not ſo far aſunder here, the ſame degree of Cold may to our Plants ſeem Tepid, which to thoſe in *Languedoc* muſt ſeem Rigorous, differing in a more remote Degree from the oppoſite Extremity of Heat in Summer.

And beſides the difference of Heat and Cold in different Climates, there is another more neceſſary to be obſerv'd, and that is, the difference of the Hardineſs in different Individuals of the ſame Species: The ſame Froſt that kills a faint languiſhing Plant of *Luſerne*, will be deſpis'd by a robuſt one, which being well fed by the Hoe, becomes a Giant cloath'd and fenc'd with a thick Bark, that renders it impregnable againſt all Weather; its Rind is to it a Coat of Mail or Buff impenetrable by Froſt: But the Unhoe'd is generally ſmall and weak, its thin tender Bark expoſes it almoſt naked to the Froſt, it being for want of a ſufficient Paſture ſtarv'd and half dead already, 'tis the more eaſily kill'd by the Cold.

I formerly liv'd ſome Years in *Languedoc*, where are many Hundred Acres of *Luſerne*; and I never could find a very large Plant amongſt it, unleſs in ſuch Pieces as had been plow'd up, till'd and ſown with Corn; here indeed thoſe Plants that remain'd (as always ſome would do) grew to an extraordinary Bulk; and one of thoſe ſingle till'd Plants did ſeem to produce a greater Quantity of Stalks, than Twenty of ſuch as had not been plow'd up; and as there were no large Plants amongſt the Unplow'd, ſo there were no ſmall amongſt the Plow'd ones. The ſame thing has been obſerv'd in all other Places where *Luſerne* has been plow'd.

And in *Wiltſhire* ſeveral Grounds of it ſtood ſome Years without ever coming to a Subſtance to be of any Value, tho' the Land was whitiſh, and ſcarce any Graſs appear'd amongſt the *Luſerne*; and therefore its Poorneſs was thought to proceed from the Soil's being improper; but when it had been broke up, and ſown ſeveral Years with Corn, and afterwards lain down with St. Foin, all the *Luſerne* Plants which remain'd (and they were many) grew large and ſtrong, ſhooting up a Yard in height ſoon after the St. Foin was cut: and if there had been a competent Number of them undeſtroy'd by the Plow, they would have yielded Crops of an extraordinary Value, where before Plowing it grew but few Inches above the Ground.

It ſeems that in this ſort of Land the Earth grows ſtale, e're the *Luſerne* arrives at a Tenth Part of its Stature; But this is moſt remarkable, that Tillage transforms thoſe *Luſerne* Plants from Dwarfs to Giants; and then they are able to contend with, if not conquer ſo ſtrong Plants as *St. Foin* are, tho' before plowing they were unable to reſiſt the Depredations of a few hairy Spires of Graſs.

Since Tillage can thus recover *Luſerne*, after it has long languiſh'd in the loweſt Ebb of Life, and reſtore it to Health, Youth and Vigour, and augment its Stature even after it has paſs'd the Age of its full Growth; To what Bulk would it arrive regularly planted, and Hoed from its Infancy to Maturity, without any Check to ſtunt it?

We can never know how poor a Soil will bear this Plant, unleſs it be try'd by the Hoeing Culture.

For 'tis wondrous how ſo great a Man as Dr. *Woodward* ſhould imagine, that Difference of Soil ſhould be the Reaſon why Apples in *Herefordſhire*, and Cherries in *Kent*, ſucceed better than in other Places, when in truth they are ſeen to proſper as well almoſt all over *England*, where planted, cultivated and preſerv'd.

This I ſuppoſe the Doctor took from *Virgil*'s *Quid quæque ferat Regio, & quid quæque recuſet*. For when the *Roman* Soldiers had, as a Reward of their Rebellion, obtain'd the Lands of their Country from the lawful Owners, their Product would have diſappointed all Expectation of Profit, if thoſe Lands ſhould have been planted with Ivory or Frankincenſe. Sure the Doctor did not conſider, how different the Soil of theſe mention'd Counties is, to that of thoſe Climates from whence Apples and Cherries were Originally brought: It muſt be greater than between that of any Two Counties in *England*. The Reaſon why no more of theſe large Plantations are made, is probably for want of ſufficient Laws to ſecure their Fruit to the Owners.

I believe Plants are more alter'd as to their Growth, by being cultivated or not, than by change of Climates differing in very many Degrees of Latitude. I ſay in their Growth, not always in their Fruit; for tho' a Peach-Tree well Cultivated in a Standard, will grow here vigorouſly, and be very beautiful; yet its Fruit will be of little Value, unleſs it be planted againſt a good Wall; ſo *Luſerne*, unleſs Cultivated upon a well expoſed Gravel, will yield little Seed in *England*.

The Soil to plant it on is either a Hot Gravel, a very rich dry Sand, or ſome other rich warm Land, that has not an under *Stratum* of Clay, nor is too near the Springs of Water; for if the Earth below be of a cold Nature, which I take to be occaſion'd by its holding of Water, the *Luſerne* will not long proſper therein, of what ever ſort the upper *Stratum* of Earth may be: This may be gueſs'd at by the Vegetables a Soil naturally produces, as Fern and the like; which Mr. *Evelyn* obſerves do Indicate a Soil ſubject to Extremities of Heat and Cold, and condemns ſuch a Soil as Accurſed. I agree to that Sentence as far as relates to Cold; but am not ſatisfy'd of its abounding with Heat, and I am ſure I know ſome Land very ſubject to Fern, which is very far from being Barren, when well cultivated and well ſuited with Vegetables; but from among theſe, *Luſerne* muſt be excluded.

Luſerne in hot Countries grows beſt near Rivers, where its Roots reach the Water, which helps to mitigate the exceſſive Heat of the Climate; but here the Heats are ſo moderate, that if *Luſerne* Roots are in Water (for 'tis That that makes Earth cold) it diminiſhes too much the juſt Proportion of Heat, which *Luſerne* requires.

The Natural Poorneſs of a Hot Gravel may be compenſated by Dung, more Heat, and the Benefit of the Hoe.

The Natural Richneſs of the other ſorts of Land being encreaſed by Hoeing, and Cleanſing it from Graſs, *Luſerne* will thrive therein with the leſs Heat; for what the Soil wants of One of theſe Two Qualities, muſt be made up with the other; and it has grown high in Hoed Rich Ground at *Chriſtmas*, when that in Land of a hotter Nature, but poorer, has not been able to peep out, for want of more Nouriſhment: So if Rich Land be Clayey, very Wet, and Cold, tho' very Rich, it requires much Heat, for as High a Growth of *Luſerne* at *Midſummer*.

The beſt Seaſon of Planting it in *England*, I take to be early in the Spring, for then there is always Moiſture to make it grow, and not Heat enough to dry its tender Root, ſo as to kill it by Malting it.

If they ſhould take ſo early a Seaſon for the common way of ſowing it, the Ground would become hard or ſtale, before the Sun were high enough to bring it forward; but there is no danger of this Inconvenience to that where the Hoe is to come, and open the Ground as oft' as there ſhall be Occaſion.

I have planted it at the End of *February*; and tho' there follow'd a very hard Froſt in *March*, which kill'd ſome part of it; yet what remain'd was of a ſufficient Thickneſs; and I believe the Quantity of Seed planted, might be after the Rate of betwixt One and Two Pounds to an Acre. The Depth it was planted at was half an Inch, which upon Trials I have found beſt for moſt ſorts of fine Seeds. I do not approve of planting it late in the Autumn, becauſe our Long Winter might kill too much of it, and weaken the reſt in its tender Infancy.

The Hoed Plants of *Luſerne* having larger Roots, and yielding more Crops than thoſe of St. Foin, Reaſon ſeems to require that the Number of the former be leſs.

But on the other hand, if we conſider, that as the *Luſerne* Roots exceed the St. Foin in Bigneſs, ſo they alſo do in Length, by as great a Proportion; being generally leſs Taper, and as they go deeper, they have more Earth to Nouriſh them. They alſo require a better Soil, and more frequent Aids from the Hoe; and by their extraordinary quick Growth, receive a ſpeedier Relief from it, than the Roots of St. Foin do.

Thus if by reaching deeper in a better Soil, and being more Hoed, *Luſerne* receives from a ſquare Perch of Ground, Nouriſhment in a Proportion Double to that whereby its Roots exceed thoſe of St. Foin in Bigneſs, then I do not ſee why we ſhould not leave the Number of *Luſerne* Plants Double to the Number of thoſe we leave in St. Foin.

But if the Exceſs of Nouriſhment were no more than the Exceſs of Bigneſs of Roots, I think an equal Number of Plants ſhould be left in *Luſerne* and in St. Foin; yet ſince the hot or cold Conſtitution of a Plant, and alſo the Quantity it can produce, ought to be conſider'd as well as its Bulk, in relation to the Nouriſhment it requires, more Trials are neceſſary for determining the exact Number of *Luſerne* Plants, proper to be plac'd on a ſquare Perch, than have been hitherto made.

Perhaps it will be thought Heterodox to maintain by any Arguments, that to err in falling ſomewhat ſhort of the juſt Number, is not of worſe Conſequence than exceeding it.

Where they ſtand at Four or Five Inches aſunder in the Rows, 'tis obſerv'd that tho' the Intervals betwixt the Rows be wide, yet the Plants are much the Larger, and produce more that ſtand in the Outſide Rows (the Ground without being Clean) and eſpecially thoſe at each End of the Outſide Rows, that is, the Corner Plants are Largeſt of all. I need not ſay, that had all the other Plants as much Room and Tillage as the Corner Ones have, they would be as Large, and produce each as much Hay; for thoſe which ſtand perfectly ſingle in Places by themſelves, are ſeen to be Larger, and produce more than thoſe Corner Ones; and of the Larger and Longer Roots our Stock does conſiſt, the more Nouriſhment are they capable of taking, as has been ſhewn.

And it muſt be likewiſe obſerv'd, that the Crop will be produc'd in Proportion to the Nouriſhment it receives; for if the moſt Gigantick *Luſerne* Plant, which when Pamper'd by the Hoe, has made a Produce more like a Tree than an Herb, remains a few Years without that or ſome equivalent Culture, it will by little and little ceaſe to produce more than a few poor ſickly Stalks, juſt to ſhew its Species, and then if this Culture be repeated, will recover its priſtine Strength, and yield as great a Crop as ever; but if that be longer omitted will die; the

Vaſtneſs of its Root availing nothing, unleſs it has Food in Proportion to it.

Hence it appears, that the moſt fatal Diſeaſe incident to *Luſerne* is Starving; and that rarely ſuffers any of its Plants to arrive at the full Period of their Growth or Age; it prevents their Fertility even in the Prime of their Youth, and kills them before they have liv'd out Half, or perhaps the Tenth Part of their Days: How long its Life might otherwiſe be, no body knows, unleſs a Plant could be found to die when well fed; for when it is, 'tis ſo tenacious of Life, that I am told Beheading will not diſpatch it (1).

'Tis therefore neceſſary that our Rows be plac'd at ſuch a Diſtance, as that their Intervals may be Wide enough for the Hoe-Plow to raiſe an Artificial Paſture, ſufficient to ſuſtain the Number of Plants in them.

Whoever ſhall make Trials of this Husbandry (for that is all I propoſe to others) I would adviſe them to begin with Rows that have Intervals of Thirty Inches; for if they begin with much narrower Diſtances, they may be by that means diſappointed of Succeſs; but tho' they ſhould afterwards find a way to Hoe them at ſomewhat nearer Diſtances; yet the loſs of a few Perches of Ground would not be much, neither can they be wholly loſt, ſince the Roots of theſe Plants may be prov'd to extend much farther Horizontally, than from Row to Row at that Diſtance. And the wider the Intervals are, the more Earth will be Till'd in a Perch of Ground; becauſe ſix Rows, which will be therein at Thirty-three Inches Diſtance, will admit the Hoe-Plow to Till more Earth, than Nine Rows at Twenty Two Inches Diſtance from each other: And beſides

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(1) But I have cut off the Heads of ſome my ſelf to try, and could not find that any One would ſprout again, tho' St. Foin will; perhaps I try'd at a wrong Seaſon.

'tis not proper that, every time of Hoeing, the Plow ſhould come very near to the Plants, unleſs when Graſs comes amongſt them; and then they may in Thirty or Thirty-three Inch Spaces, be perfectly cleanſed in this manner, *viz.* Plow a good Furrow from each ſide of every Row, and then with Harrows, or other Inſtruments proper for that Purpoſe going croſs them, you will pull out both Earth and Graſs from betwixt the Plants; then after a convenient time, plow theſe Furrows back again to the Rows, this will in a manner tranſplant the upper part of the Roots, and bury the Graſs tho' it be not dead, by lying open to be dry'd by the Sun. Then Harrow the Ground to Break it more and to Level it, and go once over it with a very light Roller, to the end that the Hay may be Raked up the cleaner.

I am aware of the common Prejudice, which is, that People, when they have never ſeen a Plantation of theſe Plants in Perfection, are apt to form to themſelves the Idea of ſuch ſmall Ones as they have been uſed to ſee; and thence imagine it impoſſible that this (tho' a Double) Number ſhould be ſufficient to make a Crop. But they might with equal Reaſon imagine the ſame of Apple-Trees at a Year's Growth, which are leſs than theſe at the ſame Age, and ſo plant a Thouſand Trees in the Room proper for One. The Ancients direct the planting of ſeventeen *Cythiſus* Plants in a Perch of Ground; and I do not believe that ever thoſe ſeventeen could yield a Crop equal to Two Hundred Twenty-four *Luſerne* Plants; for as many Ounces of Hay as each of theſe yields, ſo many Tun of Hay will One Crop of an Acre produce; thus by weighing the Product of One Plant (ſuppoſing them all equal) the Quantity of the Crop may be determin'd, and prov'd greater than Fancy from their Number repreſents.

	ſh.	d.
April 14*th*, One ſingle Unho'd Plant of *Luſerne* had 31 Stalks, which by Silver Money weigh'd green	23	0
24*th*, The ſame dry'd to Hay, weigh'd	6	6
14*th*, The Stalks of One ſingle Hoe'd *Luſerne* Plant green, weigh'd	56	0
24*th*, the ſame dry'd	14	6
14*th*, Eighteen Inches in Length of a Row, being Five indifferent Plants, weigh'd green One Pound and a Half *Avoirdupois.*		
24*th*, Dry'd to Hay, it weigh'd	28	6
25*th*, One Foot of a Hoed Row, being One Hundred and Sixty Stalks of Two *Luſerne* Plants of ſix or ſeven Years Old, weigh'd Two Pounds green.		
But the ſame dry'd to the 9th of *May* weigh'd no more than	31	6

Which laſt is about Three Tuns to an Acre.

This I am certain of, That the leaſt competent Number of Plants will bring the greateſt Number of Crops; ſince I ſee the Stalks of a ſingle Hoed Plant grow higher in fifteen Days, than One amongſt near Neighbours does in Thirty Days.

The greateſt Difference between the Culture of this and St. Foin, is, that *Luſerne* Rows ſhould be more grown, before the Plants be made ſingle in them by the Hand-Hoe, leſt the Fly ſhould deſtroy ſome afterwards, and then they might become too Thin. For *Luſerne* is ſometimes eaten by the Fly, as Turneps are, tho' St. Foin be never liable to that Misfortune, if ſown in a proper Seaſon. *Luſerne* muſt alſo be more frequently Ho'd (1) in ſome Proportion to the more frequent Crops it produces.

I ſhall

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(1) The Hoe-Plow is the Inſtrument to bring it to Perfecti-

on;

I ſhall not go about to compute the Difference of Expence beſtow'd in the *Roman* Culture, and in This; yet it will appear theirs was incomparably more Chargeable, and that that Exceſs of Charge was occaſion'd by their Error in the Theory of Husbandry.

They ſow'd it ſo Thick that the Plants muſt needs be very ſmall, and when Ten of them were no bigger than One good ſingle Hoed Plant would have been, in the ſame ſpace of the Earth's Surface, they could have but a Ninth part of the Earth's Depth, which the one would have had. The Defect of Depth muſt be therefore made up in ſome meaſure by the extraordinary Richneſs of the Surface, upon this Account few Lands were capable of bearing *Medica*. Their ſowing it ſo late, made the firſt Waterings neceſſary, and the ſhortneſs of the Roots required the repeated Rigations, after the Crops were cut: For *Columella* ſaith in *Lib.* 2. *Cap.* 11. *Cum ſecueris autem, ſæpius eam Rigato.* But had it been Cultivated by the Hoeing Method, the Tap-Roots would have deſcended as deep as a Well, and from the Springs below have ſent up Water to the Plants, beſides what the Hoe would have cauſed the Horizontal Roots to receive from Dews at the Surface above. At how much a cheaper Rate, Water is

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on; but then I doubt it muſt lie ſtill ſome Years, leſt the plow'd Earth injure the Hay that is made upon it; and when it is come to a Turf, and the *Luſerne* wants renewing. the Four Coulter'd Plow is the only Inſtrument that can prepare the Turf to be kill'd, and cure the *Luſerne*; which Plow muſt be uſed in the following manner: Turn its Furrows toward one Row, and from the next: That is, plow round one Row, and that will finiſh Two Intervals, and ſo on; and the next plowing muſt be towards thoſe Rows, from whence they were turn'd the firſt time; take care the firſt Furrows do not lie long enough on the Rows to kill the Plants, which will be much longer in Winter than in Summer.

ſupply'd by theſe means, than by carrying it perhaps a great way, and then ſprinkling it by hand over the Beds, which were made Ten Foot wide between Path and Path for that Purpoſe, let any One judge. As alſo what a laborious Task it was to pick out the Graſs with Fingers from amongſt it, in the hard dry Ground in the Summer, after mowing the Crop, as *Columella* directs in his forementi-on'd Chapter, which the Horſe-Hoe would have done with Eaſe at a Twentieth part of that Expence. However ſince they ſaw the *Medica* was as impatient of Graſs as the Vineyards were, 'tis wonder they did not give it the ſame Culture with the Bidens, which would have been much better and cheaper, than to cleanſe the *Medica* with Fingers. Indeed Fingers were made before the Bidens, but ſure the Effect of its uſe in raiſing Juices to the Vines, had inſpired the *Romans* with more judicious Speculations, than to give that for a Reaſon why they Hoed the *Medica* with their Fingers, rather than with the Bidens.

Oh! But this was made with Iron, and *Medica* had in thoſe Times an Antipathy to Iron; and after it was ſown, the Place muſt not be touch'd by that Metal; therefore the Seed muſt not be cover'd with a Plow, nor with Iron Harrows. But if they had made Trials enough, to know that Half an Inch was the proper Depth to cover this Seed at, theſe Virtuoſi would have been convinc'd, that it had no leſs Antipathy to theſe Inſtruments, of what Matter ſoever they were made, if they bury'd it five or ſix Inches deep, which the Plow muſt do, and the Weight of Iron Harrows in ſuch fine Ground, not much leſs. Had the Plow been all of Wood, the Furrow would have lain never the lighter upon the Seed; and if the wooden Harrows had been loaded with a Weight capable of preſſing it down as deep, it would have been no more able to Riſe, than if it had been buried with Iron Harrows: This *Columella* ſeems to be ſenſible of when he ſays, *Raſtellis Ligneis*, *viz.* That it was not ſufficient for them to be made of Wood, unleſs they were Diminutive, for then they were light ones. 'Tis Probable the Plow ſuffer'd none to come up, and the heavy Harrows very few, tho' perhaps Plants enough, had they calculated what Number were ſufficient: But unleſs the Ground were cover'd with them at firſt, it ſeems they had not Patience to wait till the Plants grew large enough, to fill it with a bare competent Number; and thought it not worth while to Weed and Water, what they fancy'd to be an inſufficient Number. 'Twas expected that the Thickneſs of the Plants ſhould help to kill the Graſs; yet upon due Obſervation 'tis found, that when their exceſſive Numbers have brought a Famine amongſt them, they are forc'd to prey upon one another; and tho' the ſtronger ſurvive, yet even thoſe are ſo weaken'd by Hunger, that they become the leſs able to contend with Graſs, whoſe good Fortune it was, that Superſtition would not permit the *Romans* to interpoſe, by attacking it with Iron Weapons.

I hope theſe Hints may be improv'd for the Abolition of Old Errors, and for the Diſcovery of New Truths; to the end that *Luſerne* may be planted in a more reaſonable Method than has been commonly practis'd: And when the Theory is true, 'tis impoſſible the Practice ſhould be falſe if rightly apply'd; but if it fail of Succeſs, the Event will be a Proof either of a Miſapplication, or that the Theory is falſe.

Luſerne ſhould be order'd for Hay in the ſame manner, as is directed for St. Foin in the foregoing Chapter: But it muſt be obſerv'd, that *Luſerne* is more worſted by being ſuffer'd to ſurvive its Virginity before Cutting; and therefore the Richeſt and moſt Nouriſhing Hay is cut whilſt the Stalks are ſingle, without any collateral Branches ſhooting out of them; and when they are ſo, neither Bloſſoms nor even their Buds appear. But of that ſown in the old Faſhion, the laſt Crops for want of a new Supply of Nouriſhment grew ſo ſlowly, that e'er 'tis high enough to be cut, the Bloſſoms are blown out, and the Stalks, tho' very ſmall, are become *Woody*, *Hard*, and *Dry*, and make the Hay nothing near ſo nouriſhing as that of the firſt Crops.

But in that which is Hoed, the laſt Crops of it will by vertue of the greater Quantity of Nouriſhment it receives grow faſter, and be of a Height fit to cut before bloſſoming, and thence being as young and vigorous, make as good Hay as the firſt Crops; ſo that Hoeing does not only procure more and larger Crops, but alſo better Hay.

This is moſt certain, that unleſs we can keep our *Luſerne* pretty clean from Natural Graſs, we cannot expect it to ſucceed, let the Soil be never ſo proper.

The

The following Five Chapters have been formerly Publiſh'd as a SPECIMEN.

CHAP. XVI. *Of* Change of SPECIES.

I. *That Plants of the moſt different Nature, feed on the ſame ſort of Food.*
II. *That there is no Plant but what muſt rob any other Plant within its Reach.*
III. *That a Soil which is proper to one Sort of* Vegetable, *once, is, in reſpect of the Sort of Food it gives, proper to it always.*

IF any one of theſe *Three Propoſitions* be true, as I hope to prove all of them are, then it will follow, that there is no need to change the Species of *Vegetables* from one Year to another, in reſpect to the different Food the ſame Soil is, tho' falſely, ſuppoſed to yield (1).

The common Opinion is contrary to all theſe (as it muſt if contrary to any one of them.) And ſince an Error in this fundamental Principle of *Vegetation* is of very ill Conſequence; and ſince Doctor *Woodward*, who has been ſerviceable in other Reſpects (2) to this Art, has unhappily fall'n in with the Vulgar in this Point, his Arguments for this Error, require to be anſwer'd in the firſt Place.

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(1) For if all Plants rob one another, it muſt be becauſe they all feed on the ſame ſort of Food; and admitting they do, there can be no Neceſſity of changing the Species of them, from one Soil to another; but the ſame Quantity of the ſame Food, with the ſame Heat and Moiſture which maintains any Species one Year, muſt do it any other Year.

(2) By proving in his Experiments, that Earth is the *Pabulum* of Plants.

The Doctor ſays, (1) 'It is not poſſible to imagine how one uniform, homogeneous Matter having its Principles, or Original Parts all of the ſame Subſtance, Conſtitution, Magnitude, Figure and Gravity, ſhould ever conſtitute Bodies ſo egregiouſly *unlike*, in all thoſe reſpects, as Vegetables of different Kinds are; nay, even as the different Parts of the *ſame* Vegetable.

'That there ſhould be that vaſt Difference in them, in their ſeveral Conſtitutions, Makes, Properties, and Effects, and yet all ariſe from the very ſame ſort of Matter, would be very ſtrange.'

Anſwer. 'Tis very probable, that the Terreſtrial Particles which conſtitute *Vegetables*, tho' inconceivably Minute, may be of great Variety of Figure and other Differences, elſe they could not be capable of the ſeveral Ferments, *&c.* they muſt undergo in the Veſſels of Plants. Their Smallneſs can be no Objection to their Variety, ſince even the Particles of Light are of various Kinds.

But as the Doctor aſſerts, 'That each Part of the ſame *Vegetable* requires a peculiar ſpecifick Matter for its Formation and Nouriſhment; and that there are very many and different Ingredients go to the Compoſition of the ſame individual Plants.

From hence muſt be inferred, that the ſame Plant takes in very many and different Ingredients (and it is proved, that no Plant refuſes any Ingredient that is capable of entering its Roots.) (2) Tho' the

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(1) In Philoſ. Tranſ. N. 253.

(2) Dr. *Grew*, in his Anatomy of Plants by Microſcopical Inſpection, found, that the outer Superficies of Roots was of a ſpongy Subſtance; and 'tis well known that no ſuch Body can refuſe to imbibe whatever Liquor comes in contact with it, but will by its ſpringy Poroſity abſorb any ſort of Moiſture.

Terreſtrial Particles which nouriſh *Vegetables*, be not perfectly homogeneous, yet moſt of the various Taſtes and Flavours of Plants are made in, and by the Veſſels (1).

Doctor *Woodward* ſays, 'That Water will paſs 'Pores and Interſtices, that neither Air, nor any o- 'ther Fluid will; this enables it to enter the fineſt 'Tubes and Veſſels of Plants, and to introduce the 'Terreſtrial Matter, conveying it to all Parts of 'them; whilſt each, by means of Organs 'tis en- 'dow'd with for the Purpoſe, intercepts and aſ- 'ſumes into it ſelf, ſuch Particles as are ſuitable to 'its own Nature; (2) letting the reſt paſs on *thro'* '*the common Ducts.*

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(1) We are convinced, that 'tis the Veſſels of Plants that make the different Flavours; becauſe there is none of theſe Flavours in the Earth of which they are made, until that has enter'd and been alter'd by the Vegetable Veſſels.

(2) If the Doctor's Plants were ſo nice in leaving Vegetable Matter *behind, quiet and undiſturb'd*, 'tis a wonder they would take up the Mineral Matter, as he ſays they did that kill'd themſelves with Nitre.

Theſe Plants might with much leſs Difficulty have diſtinguiſh'd the Mineral Matter from the Vegetable Matter, than they could diſtinguiſh the different Particles of Vegetable Matter from one another, and muſt have been very unwiſe to chuſe out the Nitre (their Poiſon) from the Water and Earth, and to leave the Vegetable Particles behind; none of which could be ſo improper to them as the Nitre.

It may, perhaps, be objected, that ſuch like pernicious Matter kills a Plant by only deſtroying its Roots, and by cloſing the Pores which prevents the Nouriſhment from entering to maintain its Life; aud that ſuch Matter does not it ſelf enter to act as Poiſon upon the Sap, or upon the Veſſels of the Body, or Leaves: But it plainly appears that it doth enter, and act as Poiſon; for when ſome of the Roots of a Mint, growing in Water, are put into Salt Water, it kills the whole Plant, although the reſt of the Roots remaining in the freſh Water were ſufficient to maintain it, if the other Roots had been cut off at the time they were removed into the Salt Water; and alſo all the Leaves, when dead, will be full of Salt.

Here then he ſays plainly, That each Plant receives the Terreſtrial Matter in Groſs, both ſuitable and unſuitable to its Nature, retains the ſuitable Particles for its Augment, and the unſuitable lets paſs through it. And in another Place, he ſays, they are exhal'd into the Atmoſphere.

And this will appear to be the true Caſe of Plants; and directly contradicts what he advances, in ſaying, 'That each ſort of Grain takes forth that peculiar 'Matter that is proper for its own Nouriſhment. 'Firſt, the Wheat draws off thoſe Particles that ſuit 'the Body of that Plant, *the reſt lying all quiet and 'undiſturb'd the while.* And when the Earth has 'yielded up all them, thoſe that are proper for Bar'ley, a different Grain, remain ſtill behind, till the 'ſucceſſive Crops of that Corn fetch them forth too; 'and ſo the Oats and Peaſe in their turn, 'till, in fine, 'all is carry'd off.

In the former Paragraph he ſays, Each Plant *lets paſs through it* the reſt of the Particles that are not ſuitable to its own Nature. In the latter Paragraph he ſays, That each *leaves* the Unſuitable *all behind* for another Sort; and ſo on.

Both cannot be true.

If the latter were True, Change of Sorts would be as neceſſary, as it is commonly thought. But if the former be true, as I hope to prove it is, then there can be no Uſe of Changing of Sorts in reſpect of different Nouriſhment.

If in this Series of Crops each Sort were ſo juſt as to take only ſuch Particles, as are peculiarly proper to it, letting all the reſt alone to the other Sorts to which they belonged, as the Doctor imagines; then

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Or if the Juice of wild Garlick-Seed be made uſe of inſtead of the Salt Water, it will have the ſame Effect; and every one of the Mint Leaves will have a ſtrong Taſte of Garlick in it.

then it would be equal to them all, which of the Sorts were ſown firſt or laſt: But let the Wheat be ſown after the Barley, Peaſe and Oats, inſtead of being ſown before them, and then it would evidently appear, by that ſtarv'd Crop of Wheat, either that ſome or all of thoſe other Grains, had violated this natural Probity, or elſe that Nature has given to Vegetables no ſuch Law of *Meum* and *Tuum* (1).

If theſe Things were as the Doctor affirms, why do Farmers loſe a Year's Rent, and be at the Charge of Fallowing and Manuring their Land, after ſo few Crops; ſince there are many more Sorts of Grain as different from theſe and one another, as thoſe are which they uſually ſow?

They ſtill find that the firſt Crops are beſt, and the longer they continue ſowing, the worſe the laſt Crops will prove, be they of never ſo different a Species; unleſs the Land were not in ſo good Tilth for the firſt Crop as for the ſubſequent; or unleſs the laſt ſown be of a more robuſt Species.

This Matter might be eaſily clear'd, could we perfectly know the Nature of thoſe ſuppos'd *unſui-*

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(1) A Charlock could not rob a Turnep, and ſtarve it more than ſeveral Turneps can do, unleſs the Charlock did take from it the ſame Particles which would nouriſh a Turnep; and unleſs the Charlock did devour a greater Quantity of that Nouriſhment than ſeveral Turneps could take.

Flax, Oats, and Poppy, could not burn or waſte the Soil, and make it leſs able to produce ſucceeding Crops of different Species; unleſs they did exhauſt the ſame Particles, which would have nouriſh'd Plants of different Species: For let the Quantity of Particles, theſe Burners take, be never ſo great, the following Crops would not miſs them, or ſuffer any Damage by the Want or Loſs of them, were they not the ſame Particles, which would have nouriſh'd thoſe Crops, if the Burners had left them *behind, quiet and undiſturbed.* Neither could Weeds be of any Prejudice to Corn, if they did draw off thoſe Particles only that ſuit the Bodies of Weeds, *the reſt lying all quiet and undiſturbed the while.* But conſtant Experience ſhews, that all ſorts of Weeds, more or leſs, diminiſh the Crop of Corn.

table (1) *Particles*; but, in Truth, there is no more to be known of ſuch of them, than that they are carried away by the Atmoſphere to a Diſtance, according to the Velocity of the Air; perhaps ſeveral Miles off, at leaſt, never like to return to the Spot of Ground from whence the Plants have raiſed them.

But ſuppoſe theſe caſt-off Particles were, when taken in, unfit for the Nouriſhment of any manner of Vegetables: Then the Doctor muſt fancy the Wheat to be of a very ſcrupulous Conſcience, to feed on theſe Particles, which were neither fit for its own Nouriſhment, nor of any other Plant; and at the ſame time to forbear to take the Food of Barley, Peaſe, and Oats, letting that *lie ſtill, and undiſturb'd the while*, as he ſays it does, tho' he gives no manner of Reaſon for it.

'Tis needleſs to bring ſtronger Arguments, than the Doctor's Experiments afford, againſt his own vulgar Opinion, of Plants diſtinguiſhing the particular Sort of Terreſtrial Matter, That, he ſays, is proper to each ſort of *Vegetable*, in theſe Words, *viz.* 'Each Sort takes forth that peculiar Matter 'that is proper for its own Nouriſhment, the *reſt* '*lying all quiet and undiſturb'd the while.*'

He ſays, That *great Part* of the Terreſtrial Matter, mixed with the Water, paſſes up into the Plant along with it; which it could not do, if only the *peculiar* Matter proper to each Plant, did paſs up into it: And after he has ſhewed how apt the *Vegetable*

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(1) But we muſt not conclude, that theſe Particles, which paſs through a Plant (being a vaſtly greater Quantity than thoſe that abide in it for its Augment), are all unſuitable, becauſe no one of them happens to hit upon a fit *Nidus*: For ſince the Life of Animals depends upon that of Plants, 'tis not unreaſonable to imagine, that Nature may have provided a conſiderable Overplus for maintaining the Life of individual Plants, when ſhe has provided ſuch an innumerable Overplus for continuing every Species of Animals.

Matter is to attend Water in all its Motions, and to follow it into each of its Receſſes; being by no Filtrations or Percolations wholly ſeparable from it; 'tis ſtrange he ſhould think that each Plant leaves the greateſt part of it behind, ſeparated from the Water which the Plant imbibes.

There are, doubtleſs, more than a Million of Sorts of Plants, all of which would have taken up the Water, and had each as much Right to its Share, or proper Matter in it, as the Doctor's Plants had; and then there would be but a very ſmall (or a Millionth) Part of it proper to each of his Plants, and theſe leaving all the reſt behind, both of the Water wherewith the Glaſſes at firſt were filled, when the Plants were put into them; and alſo of all the additional Water daily ſupply'd into them afterwards: I ſay, ſo much more Terreſtrial Matter brought into theſe Glaſſes, in Proportion to the added Water, and ſo very ſmall a Part as could be proper to each of his Plants being carry'd off; there muſt have remained in theſe Glaſſes a much greater Quantity of Terreſtrial Matter at the End of the Experiment, than remained in the Glaſſes *F* or *G*, which had no Plants in them, nor any Water added to, or diminiſhed from them; but the quite contrary appear'd. 'And the Water in the Glaſſes *F* and *G* at the End 'of the Experiment, exhibited a larger Quantity of 'Terreſtrial Matter, than any of thoſe that had 'Plants in them did. The Sediment at the Bottom 'of the Glaſſes was greater, and the *Nubeculæ* dif'fuſed thro' the Body of the Water thicker.' Had the *Cataputia* inſum'd with the Two Thouſand Five Hundred and One Grains of Water, no more than its proper Share of the *Vegetable Matter*, it could not have attained thence an Increaſe of three Grains and a Quarter, nor even the thouſandth part of one Grain. But he found, 'This Terreſtrial Matter,

‘ contained in all Water, to be of two Kinds: The ‘ one properly, *a Vegetable Matter*, but conſiſting ‘ of very different Particles, *ſome* of which are pro‘ per for the Nouriſhment of ſome Kinds of Plants, ‘ others for different Sorts, *&c.*

This, indeed, would have been a moſt wonderful Diſcovery, and might have given us a great Light, if he had told us in what Language and Character theſe proper Differences were ſtamp’d or written upon the *Vegetable Particles*; which Particles themſelves, he ſays, were ſcarce viſible. Certainly it muſt be a great Art (much beyond that of Dr. *Wallis*) to decypher the Language of Plants, from inviſible Characters.

Doctor *Woodward* ſeems to have had as good Eyes, and as ſtrong an Imagination, as the Old Woman, who ſaw the Needle upon the Barn, but could not ſee the Barn.

I will, by no means, call in Queſtion the Veracity of ſo learned and good a Man; and therefore am willing to believe he made this extraordinary Obſervation in his Sleep.

But that this Dream may deceive none, except ſuch who are very fond of old Errors, there is an *Experimentum Crucis* which may convince them, *viz.* At the proper Seaſon, tap a Birch-Tree in the Body or Boughs, and you may have thence a large Quantity of clear Liquor, very little altered from Water; and you may ſee that every other Species of Plants, that will grow in Water, will receive this; live, and grow in it, as well as in common Water. You may make a like Experiment by tapping other Trees, or by Water diſtilled from Vegetables, and you will find no Species of Plants, into which this Water will not enter, and paſs through it, and nouriſh it too, unleſs it be ſuch a Species as requires more Heat than Water admits; or unleſs the peculiar Veſſels of that it has firſt paſſed thro', have ſo altered the *Vegetable* Particles contained in that Water, as that it acts as Poiſon upon ſome other particular Species.

The Doctor concludes, 'That Water is only the '*Agent* that conveys the *Vegetable Matter* to the Bo'dies of Plants, that introduces and diſtributes it to 'their ſeveral Parts for their Nouriſhment. That 'Matter is *ſluggiſh* and *inactive*, and would lie eter'nally *confin'd* to its *Beds* of Earth, without ever 'advancing up into Plants, did not Water, or ſome 'like Inſtrument, fetch it forth, and *carry* it unto 'them.

That Water is very capable of the Office of a Carrier, to Plants, I think the Doctor has made moſt evident; but as to the Office of ſuch an Agent as his Hypotheſis beſtows upon it, it ſeems impoſſible to be executed by Water. For it cannot be imagined that Water, being it ſelf but mere *Homogenial Matter*, void of all Degrees of Life, ſhould *diſtinguiſh* each Particle of *Vegetable Matter*, proper and peculiar to every different Species of Plants, which are innumerable; and when 'tis to act for the Wheat, to find out all the Particles proper to that Sort of Grain, to rouſe only thoſe particular *Sluggards* from their *Beds* of Earth, *letting all the reſt lie quiet and undiſturbed the while.* This *Agent* frees the Wheat Particles from their Confinement, and conveys, introduces, and diſtributes them, and only them, into the ſeveral parts of the Wheat.

Certainly no Mortal, except Doctor *Woodward*, can pretend to diſtinguiſh the Particles of *Vegetable Matter* by any Characters, Hieroglyphicks, or other manner whatever, ſo as to determine to what Species, or Claſs of Plants, they are ſeverally proper and *peculiar*; neither is it probable, that any Botaniſt is acquainted with half the diſtinct *Species* of *Ve-*

getables. Yet all the *Vegetable Particles* and *all* the *Species* of Vegetables, muſt be perfectly and diſtinctly known by Water, before it be capable of performing ſuch a nice Task of an *Agent*; elſe, when Wheat, Barley, and Oats, are all growing together, in the ſame Foot of Ground, with their Roots ſo intangled together, that no Man can poſſibly diſtinguiſh the one from the other, by viewing the Roots: How ſhould this inſenſible *Agent* be punctual in delivering to each its own proper Particles? For, tho' the *Agent* had moſt exactly executed a Commiſſion of *diſturbing* the *Inactivity* of theſe three Sorts of Particles only; yet, when it had fetch'd them forth, if it ſhould err in the Delivery of them, and carry the Wheat-particles to the Barley, and thoſe of Barley to the Oats, it would be a Miſtake of worſe Conſequence, according to the Doctor's Opinion, than that of the *London* Undertaker's, who being to inter an old Man in *Northumberland*, and a young Lady in *Cornwall*, carried the Man to *Cornwall*, and the Lady to *Northumberland*: Her Mother, for Mitigation of Grief, would not be ſatisfied without a laſt Sight of her Daughter's Corpſe; but when the Coffin was opened, the Error was diſcover'd by the indubitable Criterion of an old ſhrivel'd Face, with a huge grey Beard. 'Tis no real Injury to a Perſon deceas'd, if the Place of his Burial be miſtaken; but if Water ſhould miſtake thus in the Taking up, Carrying, and Delivery of *Vegetable Particles*, all Plants would be (upon the Doctor's Hypotheſis) ſtarv'd or poiſon'd, and Animals could not long ſurvive all Plants. But ſince all the different Species of Plants do continue to live, their Life proves, that the *Vegetable Particles* of Earth are not proper, but *common* to them all for their Nouriſhment, if theſe Particles are taken up, carried and introduced into the *Vegetable* Veſſels by Water;

which is capable of diſtinguiſhing neither different *Vegetable Particles*, nor different *Vegetables*.

Since 'tis unreaſonable to believe, that Water can have ſuch extraordinary Skill in *Botany*, or in *Micrography*, as to be qualified for a ſufficient Agent in ſuch an abſtruſe Matter, I conceive Water to be only an Inſtrument or Vehicle, which takes up indifferently any Particles it meets with (and is able to carry) and advances them (or the *Pabulum* they yield) up into the firſt Plant whoſe Roots it comes in contact with; and that every Plant it meets with, does accept thereof, without diſtinguiſhing any different Sorts or Properties in them, until they be ſo far introduc'd and advanc'd up into the *Vegetable* Veſſels, that it would be in vain to diſtinguiſh them; for whether the Terreſtrial Matter, Plants imbibe with the Water, will kill or nouriſh them, appears by its Effects; but which cannot be foreknown or prevented without the Help of Faculties, which Plants are not endow'd with.

Mr. *Bradley* ſeems to have carried this Error farther than any Author ever did before; but he ſupports it by Affirmations only, or by ſuch Arguments (I cannot ſay Reaſons, for no Reaſon can be againſt any Truth) as go near to confute the very Opinion he pretends to advance by them.

He aſcribes to *Vegetables* the Senſe of Taſte, by which, he thinks they take ſuch Nouriſhment as is moſt agreeable to their reſpective Natures, refuſing the reſt; and will rather ſtarve than eat what is diſagreeable to their Palate.

In the Preface to his *Vol.* I. *Page* 10. of his *Huſbandry and Gardening*, he ſays, 'They feed as differently as Horſes do from Dogs, or Dogs from 'Fiſh.

But what does he mean by this Inſtance *Vol.* I. *pag.* 39? *viz.* 'That Thyme, and other Aromaticks,

‘ being planted near an Apricot-Tree, would de‘ ſtroy that Tree; helps to confirm, that every ‘ Plant does not draw exactly the ſame ſhare of Nou‘ riſhment?

I believe there is no need for him to give more Inſtances to diſprove his Aſſertion than this one. His Concluſion, taken by it ſelf, is ſo far right, *viz.* ‘ That if the Nouriſhment the Earth afforded to the ‘ Thyme and Apricot-Tree, had been divided into ‘ two Shares, both could not have had them.

But this his Inſtance proves, that thoſe Aromaticks robb'd the Apricot-Tree of ſo much of its Share as to ſtarve it; and that they, tho' of ſo very different a Nature, did draw from the Earth the ſame Nouriſhment which the Apricot-Tree ſhould have taken for its Support, had not the Aromaticks been too hard for it, in drawing it off for their own Maintenance.

Unleſs he believes that all the Juices of the Aromaticks were as Poiſon to the Apricot, and that, according to my Experiment of the Mints mark'd G and *H H*, ſome of their Roots might diſcharge ſome kind of Moiſture in dry Weather, given them by others, that had it for their Uſe; and that the Apricot-Roots, mingling with them, might imbibe enough of that Liquor, altered ſufficiently by their Veſſels, to poiſon and kill the Tree.

But then, Where was the Tree's diſtinguiſhing Palate; why did it not refuſe this Juice, which was ſo diſagreeable as to kill it? And as to his Notion of *Vegetables* having Palates, let us ſee how it agrees with what he affirms.

‘ That 'tis the Veſſels of Plants that make, by ‘ their Filtrations, Percolations, &c. all the different ‘ Taſtes and Flavours of the Matter, which is the ‘ Aliment of Plants; and that before it be by them ‘ ſo filtred, &c. it is only a Fund of *inſipid Subſtance*, ‘ ca-

‘ capable of being altered by ſuch Veſſels, into any ‘ Form, Colour, or Flavour.

And *Vol.* I. *p.* 38, ‘ The different Strainers, or ‘ Veſſels of the ſeveral Plants, growing upon that ‘ Spot of Earth, thus impregnated with Salts, alter ‘ thoſe Salts or Juices, according to the ſeveral Figures or Dimenſions of their Strainers; ſo that one ‘ Plant varies, in Taſte and Smell, from others, tho’ ‘ all draw their Nouriſhment from the ſame Stock ‘ lodg’d in the Earth.’ See Mr. *Bradley*’s *Palates of Plants*, and the *Inſipid Subſtance* he allots them to diſtinguiſh the *Taſte* of, how they agree.

They muſt, it ſeems, within their own Bodies, give the Flavour to this inſipid Subſtance, before their Palates can be of any Uſe; and even then ’tis impoſſible to be of any Uſe, but in the manner of the Dog returning to his *Vomit.*

They would have as much Occaſion for the Senſe of Smelling, as of Taſte; but after all, of what Uſe could either of the two be to Plants, without local Motion of their Roots, which they are ſo deſtitute of, that no Mouth of a Root can ever remove it ſelf from the very point where it was firſt formed, becauſe a Root has all its Longitudinal Increaſe at the very End; for ſhould the Spaces betwixt the Branchings increaſe in Length, thoſe Branches would be broken off and left behind, or elſe drawn out of their Cavities, which muſt deſtroy the Plant. All the Branches, except the foremoſt, would be found with their Extremities pointing towards the Stem; the contrary of which Poſture they are ſeen to have: And if they moved backwards, that would have much the ſame Effect on all the collateral Branchings to deſtroy them. Smell and Taſte then could be of no manner of Uſe to *Vegetables*, if they had them; they would have no Remedy or Poſſibility to mend themſelves from the ſame Mouths, removing

ing to ſearch out other Food, in caſe they had Power to diſlike or refuſe what was offered them.

Therefore, the crude Earth being their Food, ſimple and free from any Alterations by Veſſels, remaining inſipid, cannot give, neither can Plants receive, require, or make Uſe of, any Variety from it, as Animals do from their Diet. It would be loſt upon them, and Nature would have acted in vain, to give Smell and Taſte to *Vegetables*, and nothing but inſipid Earth for an Object of them; or to give them a charming Variety of Reliſh and Savour in their Food, without giving them Senſes neceſſary to perceive on enjoy them; which would be like Light and Colours to the Blind, Sound and Muſick to the Deaf; or like giving Eyes and Ears to Animals, without Light or Sound to affect them.

The Mouths of Plants, ſituate in the Convex Superficies of Roots, are analogous to the Lacteals, or Mouths, in the Concave Superficies of the Inteſtines of Animals.

Theſe ſpongy Superficies of Animal Guts, and Vegetable Roots, have no more Taſte or Power of refuſing whatever comes in contact with them, the one than the other.

The free open Air would be equally injurious to both; and if expoſed to it, it would dry and cloſe up the fine Orifices in Guts and Roots; therefore Nature has guarded both from it.

Nature has alſo provided for the Preſervation of both Vegetables and Animals (I do not ſay equally) in reſpect of their Food, which might poiſon them, or might not be fit to nouriſh them.

The Security of Plants (the beſt that can be) is their Food it ſelf, Earth; which having been altered by no Veſſels, is always ſafe and nouriſhing to them: For a Plant is never known to be poiſoned by its own natural Soil, nor ſtarved, if it were enough of it with the requiſite Quantities of Heat and Moiſture.

Roots being therefore the Guts of Plants, have no need to be guarded by Senſes; and all the parts and paſſages, which ſerve to diſtinguiſh and prepare the Food of Animals, before it reach the Guts, are omitted in Plants, and not at all neceſſary to them.

But as the Food of moſt Animals is Earth, very variouſly changed and modified by Vegetable or Animal Veſſels, or by both, and ſome of it is made wholeſom, ſome poiſonous; ſo that if this doubtful Food ſhould be committed to the Inteſtines, without Examination, as the pure unaltered Earth is to Roots, there would, in all probability, be very few Animals living in the World, except there be any that feed on Earth at firſt Hand only, as Plants do.

Therefore, leſt this Food, ſo much more refined than that of Plants, ſhould by that very Means, become a fatal Curſe, inſtead of a Bleſſing, to Animals, Nature has endowed them with Smell and Taſte, as Sentinels, without whoſe Scrutiny theſe various uncertain Ingredients are not admitted to come where they can enter the Lacteals, and to diſtinguiſh, at a ſufficient Diſtance, what is wholeſom and friendly, from what is hurtful; for when 'tis once paſſed out of the Stomach into the Guts, 'tis too late to have Benefit from Emeticks; its Venom muſt then be imbibed by the Lacteal Mouths, and mix with the Blood, as that muſt mix with the Sap, which comes in contact with the Lacteals in the Superficies of Roots, Nature having left this unguarded.

Yet, Plants ſeem to be better ſecured by the Salubrity and Simplicity of their Food, than Animals are by their Senſes: To compenſate that Inequality of Danger, Animals have Pleaſure from their Senſes, except ſome miſerable Animals (and ſuch there are) that have more pain than pleaſure from them. But, I ſuppoſe, more Animals than Plants are poiſon'd; and that a poiſonous Animal is leſs fatal to a Plant, than a poiſonous Plant is to an Animal. An Inſtance of this I have been told, by very credible Perſons, that a Man walking in a Garden, gathered a Sprig of Sage, and eat it, which ſoon brought upon him the Symptoms of Poiſon, and Death. They dug up the Root of Sage, and found a Toad under it.

Some of the Effluvia, or Excrementitious Juices of this loathſom Animal, had paſſed the Veſſels of that wholeſome Plant, without any apparent Injury to it, tho' all its Strainers were not able to correct the Venom.

Here I remark, that the Mint *(E)* ſuffered more peſtiferous Effects from the Garlick, of its own Genus, than the Sage did from the Toad, tho' of a different Genus.

It kill'd the Man, but was not ſtrong enough to kill the Sage. This ſhews, that Plants have not occaſion of Palates, as Animals have.

I ſay no more of Mr. *Bradley*'s *Vegetable Palates*; I proceed to ſome other Arguments againſt the Neceſſity of Changing Sorts of *Vegetables*, on Account of their taking different Nouriſhment.

It being ſufficiently proved, That every Sort of *Vegetables* growing in the ſame Soil, takes, and is nouriſhed by the ſame Sort of Food; it follows from hence, That the beneficial Change of Sorts of Seeds or Plants, we ſee in the common Husbandry, is not from the Quality of the Sorts of Food, but from other Cauſes; ſuch as,

I. *Quantity of the Food.*
II. *Conſtitution of the Plants.*
III. *Quantity of the Tillage.*

In Doctor *Woodward's* Caſe, upon his Hypotheſis, the three Proportions of Seeds, *viz.* Barley, Oats, and Peaſe, might be ſown all together in the ſame Acre of Ground, the ſame Year, and make three as good Crops as if ſown ſingly in three ſucceſſive Years, and his two Crops of Wheat in one Year likewiſe. But every Farmer can tell, that theſe three proportions of Seed would not yield half the Crop together, as one would do ſingle; and would ſcarce produce more than to ſhew what Grains were ſown, and which of the Sorts were the ſtrongeſt, and the moſt able Robber.

Though this Failure would, in Truth, be from no other Cauſe than want of the ſufficient Quantity of Food, which thoſe three Crops required; yet, perhaps, the Doctor might think that all three Crops might ſucceed together very well, taking each its proper Nouriſhment, were it not for want of *Room*, *Air*, and *Sun*.

I have been credibly inform'd, that on one Perch of Ground there has grown a Buſhel of Corn, which is twenty Quarters to an Acre. Mr. *Houghton* relates twenty-ſix, and even thirty Quarters of Wheat on one Acre. There has certainly grown twelve Quarters of Barley to an Acre, throughout a whole Field: Therefore, unleſs a Crop exceed the leaſt of theſe, or, indeed, the greateſt of them (if the Relation be true) a Crop cannot fail for want of Room; for one Acre (be it of what Nature it will, as to the Soil of it) muſt have as much Room for a Crop to grow on, as any other Acre.

Then there was Room for all Dr. *Woodward's* three Crops together, to produce as much as three common Crops do. Yet all theſe together will ſcarce yield one Quarter of Corn, tho' there is Room at leaſt for Twelve.

The ſame *Air* and *Sun* that had Room to do their Office to Mr. *Houghton*'s Acre, why ſhould they not have Room to do the ſame to Doctor *Woodward*'s Acre, when the three Crops growing on it at once, tho' pretty good ones, might require leſs Room than Mr. *Houghton*'s Crop did?

I perceive that thoſe Authors, who explain Vegetation, by ſaying the Earth imbibes certain Qualities, from the Air, and by ſpecifick Qualities, and the like, do alſo lay a great Streſs upon the *Perpendicular* Growth of *Vegetables*; ſeeming to fancy there is little elſe neceſſary to a good Crop, but Room.

Mr. *Bradley* in his Arguments concerning the Value of a Hill, does implicitly ſay as much.

But if they would but conſider the Diameters of the Stems, with the Meaſure of the Surface of an Acre, they would be convinced, that many, even of Mr. *Houghton*'s Crops, might ſtand in a perpendicular Poſture upon an Acre, and Room be left.

One true Cauſe of a Crop's Failing, is want of a Quantity of Food to maintain the Quantity of *Vegetables* which the Food ſhould nouriſh.

When the Quantity of Food which is ſufficient for another Species (that requires leſs) but not for that which laſt grew, to grow again the next Year, then that other is beneficial to be planted after it.

The ſecond true Cauſe is from the Conſtitution of Plants; ſome require more Food than others, and ſome are of a ſtronger Make, and better able to penetrate the Earth, and forage for themſelves.

Therefore Oats may ſucceed a Crop of Wheat on ſtrong Land, with once plowing, when Barley will not; becauſe Barley is not ſo well able to penetrate as Oats, or Beans, or Peaſe are.

So a Pear-Tree may ſucceed a Plum-Tree, when another Plum-Tree cannot; becauſe a Pear is a much ſtronger Tree, and grows to a much greater Bulk, ſo enclined to be a Giant, that 'tis hard to make it a Dwarf; and will penetrate and force its Way thro' the untill'd Earth, where the other cannot, being of a weaker and leſs robuſt Conſtitution, not ſo well able to ſhift for it ſelf.

The Pear could penetrate Pores that the other could not. Mr. *Evelyn* ſays, in his Diſcourſe of Foreſt-Trees, 'That a Pear will ſtrike Root through 'the rougheſt and moſt impenetrable Rocks and Clifts 'of Stone it ſelf.' He ſays likewiſe, in his *Pomona*, 'That Pears will thrive where neither Apple or o'ther Fruit could in Appearance be expected.'

I can ſcarce think, that a large Plant takes in larger particles than a ſmall one for its Nouriſhment; if it did, I can't believe, that the Thyme could have ſtarv'd the Apricot-Tree; it muſt have left the larger particles of Food for that Tree, which probably would have ſufficed to keep it alive; I rather think, that great and ſmall plants are ſuſtain'd by the ſame minute particles: For as the fine particles of Oats will nouriſh an *Ox*, ſo they will nouriſh a *Tom-Tit*, or a *Mite*.

Some Plants are of a hotter Conſtitution, and have a quicker Digeſtion, like Cormorants or Pigeons, devouring more greedily, and a greater Quantity of Food than thoſe of a colder Temperature, of equal Bulk, whoſe Sap having a more languid Motion, in proportion to the leſs Degree of Heat in it, ſends off fewer Recrements, and therefore a leſs Supply of Food is required in their Room. This may make ſome Difference in the one's ſucceeding the other; becauſe the hot-conſtitution'd leaves not enough for its own Species to ſucceed again, but leaves enough for a Species of a colder Conſtitution to ſucceed it.

But the third and chiefeſt Cauſe of the Benefit of changing Sorts, is Quantity of *Tillage*, in proportion to which the Food will be produced.

The true Cauſe why Wheat is not (eſpecially on any ſtrong Soil) to be ſown immediately after Wheat, is, That the firſt Wheat ſtanding almoſt a Year on the Ground, by which it muſt grow harder; and Wheat Seed-Time being ſoon after Harveſt in *England*, there is not Space of Time to Till the Land ſo much as a ſecond Crop of Wheat requires.

Tho' ſometimes in poorer Land that is lighter, Wheat has ſucceeded Wheat with tolerable Succeſs, when I have ſeen on very rich ſtrong Land, the firſt Crop loſt by being much too big, and one following it immediately, quite loſt by the poorneſs of it, and not worth Cutting.

This was enough to ſatisfy, that the *Tillage* which was ſo much eaſier perform'd in leſs time, ſufficed for the light Land, but not for the ſtrong; and if the ſtrong Land could have been brought into as good Tilth as the light, (like as in the *New Huſbandry* it may) it would have produced a much better Second Crop than the light Land did.

From all that has been ſaid, theſe may be laid down as Maxims, *viz.* That the ſame Quantity of *Tillage* will produce the ſame Quantity of Food in the ſame Land: *And*, That the ſame Quantity of Food will maintain the ſame Quantity of *Vegetables*.

'Tis ſeen, that the ſame Sort of Weeds which once come naturally in a Soil, if ſuffer'd to grow, will always proſper in proportion to the Tillage and Manure beſtow'd upon it, without any Change. (And ſo are all manner of plants that have been yet try'd by the *New Husbandry*, ſeen to do).

A Vineyard, if not Tilled, will ſoon decay, even in rich Ground, as may be ſeen in thoſe in *France*, lying intermingled as our Lands do in Common Fields. Thoſe Lands of Vines, which by reaſon of ſome Law-Suit depending about the Property of them, or otherwiſe, lie a Year or two Untilled, produce no Grapes, ſend out no Shoots hardly; the Leaves look yellow, and ſeem dead, in Compariſon of thoſe on each Side of them, which being Tilled, are full of Fruit, ſend out a Hundred times more Wood, and their Leaves are large and flouriſhing; and continue to do the ſame annually for Ages, if the Plow or Hoe do not neglect them.

No Change of Sorts is needful in them, if the ſame annual Quantity of *Tillage* (which appears to provide the ſame Annual Quantity of Food) be continued to the Vines.

But what in the *Vineyards* proves this Theſis moſt fully, is, That where they conſtantly Till the low Vines with the Plow, which is almoſt the ſame with the Hoe-plow, the Stems are planted about four Foot aſunder, Chequer-wiſe; ſo that they plow them four Ways. When any of theſe Plants happen to die, new ones are immediately planted in their Room, and exactly in the Points or Angles, where the other have rotted; elſe, if planted out of thoſe Angles, they would ſtand in the Way of the Plow. Theſe young Vines, I ſay, ſo planted in the very Graves, as it were, of their Predeceſſors, Grow, Thrive, and Proſper well, the Soil being thus conſtantly Tilled: And if a Plum-Tree, or any other Plant had ſuch Tillage, it might as well ſucceed one of its own Species, as thoſe Vines do.

'Tis obſerved, that White-Thorns will not proſper ſet in the Gaps of a White-Thorn Hedge: But I have ſeen the Banks of ſuch Gaps dug, and thrown down one Summer, and made up again, and White-Thorns there re-planted the following Winter, with good Succeſs.

But Note, That the annual plowing the Vines is more beneficial than the one Summer *Tillage* of the Banks, the Vines having it repeated to them yearly.

I have by Experience and Obſervation, found it to be a Rule, That *Long Tap-rooted Plants*, as *Clover* and *St. Foin*, will not ſucceed immediately after thoſe of their own or any other Species of *Long Tap-Roots*, ſo well as after *Horizontal-rooted* Plants; but, on the contrary, Horizontal, will ſucceed thoſe *Tap-Roots* as well or better than they will ſucceed Horizontal.

I confeſs, this Obſervation did, for a great while, *cheat* me into the common Belief, That different Species of Plants feed on different Food; till I was delivered from that Error, by taking Notice, that thoſe *Tap-Roots* would thrive exceedingly well after Turneps, which have alſo pretty long *Tap-Roots*, tho' Turneps never thrive well immediately after *Clover* or *St. Foin*; I found the true Cauſe of this Exception to that Rule, to be chiefly the different *Tillage* (1).

Land muſt be well Tilled for Turneps, which alſo are commonly Ho'd; they ſtand ſcarce ever above three Quarters of a Year, and are then fed on the Ground, and then the ſucceeding Crop of Corn has, by that means, the Benefit of twice as much Tillage from the Hoe as otherwiſe would be given to it; and the *Broad Clover* or *St. Foin*, ſown with the Corn (if the Corn be not ſo big as to kill it) will enjoy, in its Turn, a proportion of the extraordinary *Tillage*, and of the Dung of Cattle, which feed the Turneps, and thrive accordingly: But *Broad Clover* and *St. Foin*, being perennial Plants, ſtand on the Ground ſo long, that it lies ſeveral Years untilled; ſo that Turneps, ſown immediately after theſe, do fail, for want of their due Tillage, for which there is not ſufficient Time, by plowing often enough, becauſe, by the common Plows, it requires two or three Years to make it fine enough for Turneps, or for a Repetition of *Clover* or *St. Foin*, in ſtrong or ſwerdy Land.

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(1) Very mellow rich Land is ſo full of Vegetable Food, that 'tis an Exception to moſt Rules; and therefore I ſpeak not of That.

Another Reaſon why any Crop ſucceeds well after Turneps (and beſides their being ſpent on the Ground where they grow) is their cold Conſtitution, by which they are maintained with leſs Food than another Plant of the ſame Bulk.

The *Parenchyma*, or fleſhy part of a Turnep, conſiſting of a watry Subſtance, which cools the Veſſels, whereby the Sap's Motion is very ſlow, in proportion to the very low Degree of Heat it has, and ſends off its Recrements in the ſame Proportion likewiſe; and therefore requires the leſs of the terrene Nouriſhment to ſupply thoſe Recrements.

This is ſeen, when a Buſhel of Turneps mix'd with a Quantity of Wheaten Flour, is made into Bread, and well baked: This Buſhel of Turneps gives but few Ounces Increaſe in Weight, more than the ſame Quantity of Wheaten Flour made into Bread, and baked without any Turneps. This ſhews there is in a Turnep very little Earth (which is the moſt permanent Subſtance of a Plant) the Oven diſcharges, in Vapour, near all but the largeſt Veſſels: Its Earthy Subſtance being ſo ſmall, is a Proof 'tis maintained by a ſmall Quantity of Earth; and upon that Account, alſo of leſs Damage to the next Crop than another Plant would be, which required more of the ſolid Nouriſhment to conſtitute its firmer Body, as a Charlock does; for when a Charlock comes up, contiguous to, and, at the ſame time, with, a Turnep, it does ſo rob the Turnep, that it attains not to be of the Weight of five Ounces; when a ſingle Turnep, having no more Scope of Ground, and, in all reſpects (but the Vicinity of the Charlock) equal, weighs five Pounds, yet that Charlock does not weigh one Pound.

And where Three Turneps coming up, and growing thus contiguous, will weigh four Pounds; a Charlock joined with two or three Turneps, altogether will be leſs than one Pound, upon no leſs Space of Ground.

This Obſervation cannot be made, except where Turneps are drill'd in Rows; and there 'tis eaſy to demonſtrate, that a Charlock, during the time of its ſhort Life, draws much more Earth than a Turnep of equal Bulk, from an equal Quantity of Ground (1).

The true Cauſe why *Clover* and *St. Foin* do not ſucceed ſo well after their own reſpective Species, or that of each other, as Corn, *&c.* can, is, that they take great part of their Nouriſhment from below the Plow's Reach, ſo as that Under-Earth cannot be tilled deep enough, but the upper part may be tilled deep enough for the Horizontal Roots of Corn, *&c.* towards which, the Rotting of the *Clover* and *St. Foin* Roots, when cut off by the Plow, do not a little contribute. And there is no doubt but that, if the Under-Earth could be as well tilled for the

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(1) 'Tis certain that Turneps, when they ſtand for Seed, ſuck and impoveriſh the Ground exceedingly; for though they are of a cold Conſtitution, and conſequently conſume leſs Food than Plants of a hotter Conſtitution, and of the ſame Bulk: Yet, theſe Seed-Turneps being of ſo vaſt a Bulk, as ſometimes eighty Quarters of their Roots grow on an Acre, and their Stalks have been meaſured ſeven Foot high; and their Roots having continued at near their full Bigneſs for about Ten Months together, and then carried off, they drain the Land more than a Crop of other Vegetables of leſs Bulk and a hotter Conſtitution, and which live a leſs Time; or than Wheat, which, though it lives as long, is very ſmall, except in the four laſt Months.

Tap-Roots, as the upper Earth is for the Horizontal, the Tap-Roots would ſucceed one another as well as the Horizontal would ſucceed them, or thoſe of their own Species, or, as the Tap-Roots do the Horizontal.

The Under-Earth, in ſome time, is repleniſh'd by what the Rains leave, when they ſink through it; and then Tap-rooted Plants may be there nouriſhed again, tho' the Upper Earth be drained by the Corn; ſo that no Change is ſo beneficial, as that betwixt Tap-rooted Plants, and thoſe which have only Horizontal ones. The former are provided for by Rains, tho' not ſo ſpeedily as the latter are by Tillage and Hoeing.

Paſtures require no Change of Herbs; becauſe they have annually the ſame Supply of Food from the Dunging of Cattle that feed on them, and from the Benefit of the Atmoſphere.

Meadows hold out without Change of Species of Graſs, tho' a Crop be carried off every Year; the Richneſs of that Soil, with the Help of the Atmoſphere, Dung of Cattle in feeding the After-Crop, or elſe Flooding, from the overflowing of ſome River, ſome, or all of which, ſupply the Place of the Plow to a Meadow.

Woods alſo hold out beyond Memory or Tradition, without changing Sorts of Trees; and this, by the Leaves, and, perhaps, old Wood rotting on the Soil annually, which operate as a Manure, becauſe, as has been ſaid, Earth which has once paſſed any Veſſels, is ſo changed, that for a long time after, it does not regain its *Homogeneiety* (1) ſo much as to mix with pure Earth, without fermenting; and by the Deſcent of the Atmoſphere, the Trees ſhadowing the Soil, to prevent the Re-aſcent of what that brings down; all this reſembling Tillage, continually divides the Soil, and renews the Food equal to the Conſumption of it made by the Wood.

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(1) Not that the Particles of Earth are ſtrictly *Homogeneous*, but that they are much leſs *Heterogeneous* before they are altered by Veſſels, than afterwards.

And the laſt Argument I ſhall attempt to bring for Confirmation of all I have advanc'd is, that which proves both the Truth and Uſe of the reſt, *viz.* That when any Sort of *Vegetable*, by the due Degrees of Heat and Moiſture it requires, is agreeable to a Soil, it may, by the *New Horſe-Hoeing Husbandry*, be continued without ever changing the Species.

CHAP. XVII. *Of Change of* INDIVIDUALS.

SEEDS, in their natural Climate, do not degenerate, unleſs Culture has improved them; and then, upon Omiſſion of that Culture, they return to their firſt natural State.

As the Benefit of changing of *Species* of Seeds, is from Difference of *Tillage*, ſo the Benefit of changing *Individuals* of the ſame Species, appears to be from thoſe Cauſes, which are generally, themſelves, the Effects of different Climates, ſuch as Heat and Moiſture, which may alſo vary very much in the ſame Latitude and Neighbourhood; as the ſame Mountain, in the Country of the *Mogul* (related by Mr. *Evelyn*, from Monſieur *Bernier*) on the South Side produces *Indian* Plants, and on the North Side *European* Plants, from different Expoſures; and ſome Land retaining Water longer, is colder; ſome ſuffering it to paſs down quicker, and by the Nature and Figure of its Parts, cauſes ſuch a Refraction, and Reflection of the Sun's Rays, which give a great

Warmth, as in Sand and Gravelly Grounds, that are well ſituate, and have an *Under-Stratum* of ſome Sort of hollow Matter, next under the Staple, or *Upper-Stratum*, wherein the Plow is exerciſed.

This beneficial *Change of Individuals* ſeems rather to be from the forementionꞌd Cauſes, than from Change of Food; and theſe Cauſes ſhew their Efficacy, chiefly in the Generation, or Fœtation of thoſe Seeds; as Flax-Seed brought from *Holland*, and ſown here, will bring as fine Flax as there; but the very next Generation of it *coarſer*, and ſo degenerating gradually, after two or three Deſcents, becomes no better than the common ordinary Sort; yet its Food is the ſame, when the Flax is fine, as when 'tis coarſe.

And ſo it is when *Individuals* of Wheat are changed; ſo Silk-Worms, hatch'd and bred in *France*, of Eggs or Seed, brought from *Italy*, will make as fine Silk as the *Italian*; but the Eggs of theſe laid in *France*, and their Iſſue, will make no better Silk than the *French*; tho' their Food be from Leaves of the ſame Mulberry Trees, when they make *fine* Silk and *coarſe*; therefore 'tis from the Climate, where the Eggs are impregnated, not where they have their Incubation, or Food when hatch'd, and fed to their Lives-End, that this Difference happens.

Common Barley ſown once in the burning Sand, at *Patney* in *Wiltſhire*, will, for many Years after, if ſown on indifferent warm Ground, be *ripe* two or three Weeks ſooner than any other, which has never been impregnate at *Patney*: But if ſown a Degree farther North, on cold, clayey Land, will, in two or three Years, *loſe* this Quality, and become as late ripe as any other.

Indeed, *Patney* is far from improving the Species of Barley, except we think it improved by becoming more weak and tender, and *ſhorter-lived*; which laſt mention'd Quality fits it for ſuch Countries, where the Summers are too ſhort for other Barley to ripen.

The Grains, or Seeds of *Vegetables*, are their Eggs, and the *Individual Plants*, immediately proceeding from them, have not only the Virtues they received in Embryo (or rather in *Plantulis*) but the *Diſeaſes* alſo; for when ſmutty Wheat is ſown, unleſs the Year prove very favourable, the Crop will be ſmutty; which is an evident Token of *Mala Stamina*.

The ſmutty Grains will not grow, for they turn to a black Powder, but when ſome of theſe are in a Crop, then, to be ſure, many of the reſt are infected; and the Diſeaſe will ſhew it ſelf in the next Generation, or Deſcent of it; if the Year wherein 'tis planted, prove a wet one.

Weeds, and their Seed, in the Fields where they grow naturally, for Time immemorial, come to as great Perfection as ever, without Change of Soil.

Theſe Weeds, with Acorns, and other Maſts, Crabs, Sloes, Hips, and Haws, are thought to have been, originally, the only natural Product of our Climate; therefore, other Plants being Exoticks, many of them, as to their *Individuals*, require Culture, and Change of Soil, without which they are liable, more or leſs, to degenerate.

But to ſay, that the Soil can cauſe Wheat to degenerate into Rye, or convert Rye into Wheat, is what reflects upon the Credit of *Laurembergius*: 'Tis as eaſy to believe, that a Horſe, by feeding in a certain Paſture, will degenerate into a Bull, and in other Paſture revert to a Horſe again; theſe are ſcarce of more different Species than Wheat and Rye are: If the different Soil of *Wittemberg*, and *Thuringia*, change one Species, they may the other.

Chap. XVIII. *Of RIDGES.*

THE Method of plowing Land up into *Ridges*, is a particular ſort of *Tillage*; the chief Uſe of which is the Alteration it makes in the Degrees of Heat and Moiſture, being two of the grand Requiſites of *Vegetation*; for very different Degrees of theſe are neceſſary to different Species of *Vegetables*.

Thoſe *Vegetables* commonly ſown in our Fields, require a middle Degree of both, not being able to live on the Sides of perpendicular Walls in hot Countries, nor under Water in cold ones, neither are they amphibious, but muſt have a Surface of Earth not cover'd, nor much ſoak'd with Water, which deprives them of their neceſſary Degree of Heat, and cauſes them to languiſh. The Symptoms of their Diſeaſe are a pale or yellow Colour in their Leaves, and a Ceſſation of Growth, and Death enſues as ſure as from a Dropſy.

The only Remedy to prevent this Diſeaſe in Plants, is to lay ſuch wet Land up into *Ridges*, that the Water may run off into the Furrows, and be convey'd by Ditches or Drains into ſome River.

The more a Soil is fill'd with Water, the leſs Heat it will have.

The two ſorts of Land moſt liable to be over-glutted with Water, are Hills whereof the *Upper-Stratum* (or Staple) is Mould lying upon a *Second Stratum* of Clay.

And generally all ſtrong deep Land.

Hills are made wet and ſpewy by the Rain-water which falls thereon, and ſoaks into them as into other Land; but being ſtopp'd by the Clay lying next the Surface or Staple, cannot enter the Clay; and for want of Entrance, ſpreads it ſelf upon it; and as Water naturally tends downwards, it is by the incumbent Mould partly ſtopp'd in its Deſcent, from the upper, towards the lower ſide of an Hill; and being follow'd and preſs'd on by more Water from above, is forced to riſe up into the Mould lying upon it, which it fills as a Ciſtern does a Fountain (or *Jette d'Eau)*. The Land of ſuch a Hill is not the leſs wet or ſpewy for being laid up in *Ridges*, if they be made from the higher to the lower part of the Field; for the Force of the Water's Weight continued, will raiſe it ſo, as to cauſe it to iſſue out at the very Tops of thoſe Ridges: The Earth becomes a ſort of Pap or Batter, and being like a Quagmire, in going over it, the Feet of Men and Cattle ſink in 'till they come to the Clay; the upper Mould is near the Condition of the *Chaos Inſtabilis Terræ.*

There are two Methods of Draining ſuch a wet Hill: The one is to dig many Trenches croſs the Hill Horizontally, and either fill them up with Stones looſe or Arch-wiſe, through which the Water, when it ſoaks into the Trenches, may run off at one or both Ends of them into ſome Ditch which is lower, and carries it away: Then they cover the Trenches with Mould, and plow over them as in dry level Ground.

This Method has been found effectual for a Time, but not of long Continuance; for the Trenches are apt to be ſtopp'd up, and then the Springs break out again as before: Beſides, this is a very chargeable Work, and in many Places, the Expence of it may almoſt equal the Purchaſe of the Land.

Therefore, 'tis a better Method to plow the *Ridges* croſs the Hill, almoſt horizontally, that their parting Furrows lying open, may each ſerve as a Drain to the *Ridge* next below it; for when the

Plow has made the Bottom of theſe Horizontal Furrows a few Inches deeper than the Surface of the Clay, the Water will run to their Ends, very ſecurely, without riſing into the Mould, provided no part of the Furrows be lower than their Ends.

Theſe parting Furrows, and their Ridges, muſt be made more or leſs oblique, according to the Form and Declivity of the Hill; but the more Horizontal they are, the ſooner the Rain-Water will run off the Lands; for in that Caſe it will run to the Furrows, and reach them at right Angles, which it will not do when the Ridges (or Lands) are oblique; and therefore the Water's Courſe croſs the Lands will be longer. Every one of theſe Horizontal Trenches, receives all the Water from the Rills or little Gutters wherein the Water runs betwixt the Mould and the Clay; theſe are all cut off by the Trenches, which receive the Water at their upper Sides, and carry it away, as the Trunks of Lead plac'd under the Eaves of a Houſe do carry away the Rain-Water.

If there were no other Manner of plowing Ridges on the Sides of Hills than what is commonly practiſed on the Plains, this Method of leaving open Furrows (or Drains on Declivities) would be impracticable; becauſe the Plow could not turn up the Furrows againſt the Hill and againſt the Ridge alſo, from the lower Side of it: But the eaſy Remedy againſt that Inconvenience, is to plow ſuch Ridges in Pairs, without throwing any Earth into the Trenches, and then the Ridges will be plain atop, and the Rain-Water will run ſpeedily downward to the next Trench, and thence to the Head-Land, and ſo out of the Field. Theſe Trenches will be made, as well as kept, always open by this plowing in Pairs, and is abundantly more eaſy than the Way of plowing Ridges ſingly. This plowing in Pairs prevents alſo another Inconveniency which would otherwiſe happen to theſe Horizontal Ridges; and that is, they being higheſt in the Middle, the Rain-Water could not run freely from the upper Half of a Ridge towards the next Furrow below it, but would be apt to ſink in there, and ſoak through the Ridge; but when Ridges lie in Pairs, the Water will run off from a whole Ridge, as well as off the lower Half of a Ridge that is plow'd ſingly, and higheſt in the Middle.

Note, That every Time of plowing, the Pairs muſt be changed, ſo that the Furrow, which had two (Lands or) Ridges turned towards it one time, muſt have two turn'd from it the next time: This Method keeps the Surfaces of all the Ridges (or Lands) pretty near even (1).

Farmers are at more Trouble and Pains to drown ſuch Land (it being common to break their Horſes Wind in plowing up Hill) than they would be at, if they laid their Ridges in the abovesaid Manner, which would effectually make them dry. Many Hundred Acres of good Ground are ſpoiled; and many a good Horſe, in plowing againſt the Hill, and againſt all Reaſon, Demonſtration, and Experience too, which might be learned even from the *Iriſh*, who drain their Bogs and make them fruitful, whilſt ſome *Engliſh* beſtow much Labour to drown and make barren many of their Hills, which would more eaſily be made dry and fertile.

I have obſerved, that thoſe Places of ſuch a Hill, when plowed with the Deſcent, were the wetteſt, and never produced any thing that was ſown on them, became the very richeſt, when made dry by plowing croſs the Deſcent. This ſhews that Water does not impoveriſh Land, but the contrary; though, whilſt it ſtands thereon, it prevents the Heat which is neceſſary to the Production of moſt Sorts of *Vegetables*: And where it runs ſwiftly, it carries much Earth away with it; where it runs ſlowly, it depoſites, and leaves much behind it.

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(1) *Note*, This cannot be done on a Hill, whoſe Declivity is ſo great, that the Plow is not able to turn a Furrow againſt it. But in this Caſe, perhaps, it may be ſufficient to plow the Ridges obliquely, enough for the Furrow to be turned both Ways.

Though, in all Places where this Way of making the Ridges croſs the Deſcent of Hills is practiſed, the Land becomes dry, yet very few Farmers will alter their old Method; no, not even to try the Experiment; but ſtill complain their Ground is ſo wet and ſpewy, that it brings them little or no Profit; and if the Year prove moiſt, they are great Loſers by ſowing it (1).

The Benefit of laying up ſtrong deep Land into Ridges, is very great; tho' there be no Springs in it, as are in the Hills aforementioned.

This Land, when it lies flat, and is plowed in the *Virgilian* Manner, ſometimes one way, ſometimes the other, by croſs plowing, retains the Rain-Water a long time ſoaking into it; by that Misfortune, the Plow is kept out two or three Weeks longer than if the ſame were in round Ridges; nay, ſometimes its Flatneſs keeps it from drying till the Seaſon of plowing, and even of ſowing too, be loſt.

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(1) Remember, in making Ridges of all Sorts, and of whatſoever Figure the Piece is, that no Ridge ought to have any more Furrows at one End, than at the other End; for if there be, the Plow muſt be turned in the Middle of the Piece, which will cauſe the Land to be trodden by the Horſes; but if each End have an equal Number of Furrows, the Horſes, in turning, will tread only upon the Head-Lands, which may be plowed afterwards; or if deſign'd to be Horſe-Hoed, the Head-Lands ſhould be narrow, and not plowed at all.

The Reaſons commonly given againſt ſuch Ridges, are theſe following.

I. *They prevent the fancied Benefit of Croſs-Plowing.*
II. *Farmers think they loſe part of their Ground, by leaving more Furrows betwixt Ridges, than when they lay their Land flat, where the Lands are made much larger than round Ridges can conveniently be: And becauſe, alſo, the Furrows betwixt Ridges muſt be broader, and lie open; but the other they fill up by the Harrows.*

The firſt of theſe I have already anſwered elſewhere, by ſhewing, that Croſs-plowing is oftner injurious than beneficial.

The *Second*, I ſhall ſufficiently confute, if I can make appear that no Ground is loſt, but much may be gained by Ridges.

What I mean by gaining of Ground, is the increaſing of the Earth's Surface; for if a flat Piece be plow'd up into Ridges, and if in each ſixteen Foot Breadth, there be an empty Furrow of two Foot; and yet by the Heighth and Roundneſs of the Ridges, they have eighteen Foot of Surface, capable of producing Corn equally to eighteen Feet, whilſt the Piece was flat, there will be one eighth part of profitable Ground, or Surface, gain'd more than it had when level; and this, I believe, Experience will prove, if the Thing were well examined into.

But againſt this Increaſe of profitable Ground, there is an Objection, which I muſt not call a frivolous one, in reſpect to the Authors who bring it; yet, I hope, the Deſire of finding the Truth, will juſtify me to examine it, and the Arguments brought to ſuſtain it.

This Opinion of theirs is founded upon their Notion (which, I think, very erroneous) of the Perpendicular Growth of *Vegetables*, and is, by Mr. *Brad-*

Bradley, ſet in its beſt Light, in his *Vol.* I. *Page* 8. *uſque ad Page* 13. and in his Cuts repreſenting three Hills; but his Arguments ſeem to be ſuch, as all Arguments are, which pretend to prove a Thing to be what it is not, *viz.* Sophiſtical ones.

The Hypotheſis he endeavours to prove, is in *Page* 8. thus: ‘A Hill may contain four equal ‘Sides, which meet in a Point at the Top; but the ‘Contents of theſe four Sides, can produce no more, ‘either of Grain or Trees, than the plain Ground, ‘upon which the Hill ſtands, or has its Baſe; and ‘yet, by the Meaſure of the Sides, we find twice ‘the Number of Acres, Roods, and Poles, which ‘meaſures in the Baſe, or Ground Plat; and there‘fore, *Page* 9. Hills are worth no more than Half ‘their Superficial Meaſure; *i. e.* two Acres upon ‘the Side of the Hill to pay as much as one upon ‘the Plain, provided the Soil of both is equally ‘rich.’

To prove it, he gives an Example in *Fig.* III. of Buildings upon a Hill; ſhewing, that the two Sides of the Hill, will only bear the ſame Number of Houſes, that may ſtand in the Line at the Baſe.

This is foreign to the Queſtion, of how much Grain, or how many Trees, the Hill will produce. For *Vegetables* being fed by the Earth, require much more of its Surface to nouriſh them, than is neceſſary for them to ſtand on; but Buildings require no more of the Surface but Room to ſtand on: Therefore, no ſuch Argument, taken from Buildings, can be applied to *Vegetables*.

This Argument of Mr. *Bradley*'s, gives no more Satisfaction to the Queſtion, about producing of *Vegetables*, than a Grazier would do, being asked, how many Oxen a certain Paſture Ground would maintain, if he ſhould anſwer, by ſatisfying you with the Number of Churches which might ſtand thereon.

The like Anſwer, in Effect, may be given to the Argument in *Fig*. IV. of the Pales, only he has forgot to ſhew, that to mound over the Hill would require double the Rails, or double the Hedge-wood (except Stakes) as to mound the Baſe; if it did not, the Hill would be yet of the more Value, becauſe thereon more Surface might be fenced in at leſs Expence.

In his *Fig*. II. he gives no good Reaſon why the Hill ſhould not bear twice the Number of Trees as the Baſe can do; for there is as much Room for two Hundred Trees on the Hill, as for one Hundred on the Baſe, becauſe he allows the Surface to be double to that of the Baſe. He ought to meaſure the Diſtances of the Trees on the Hill, by a Line parallel to the Surface they grow on, as well as he does the Diſtances of thoſe below.

And ſuppoſe the Row at the Baſe, together with the Surface they grow on, were rais'd up, ſo that it ſhould become parallel to Half the Row on the Hill, would not the Trees in the Baſe Row be twice as near to one another as the Trees in the Hill Row are? And ſuppoſe a Line had been ty'd from the Tops of all the lower Trees before the Row was ſo rais'd up at one End, and then after the Situation of the Row was ſo alter'd, if by this Line the Trees ſhould be pull'd from being perpendicular to the Surface they grow on, and made to ſtand oblique to that, and perpendicular to the Horizon, as the upper Trees are, would the Diſtances of the Trees from one another be alter'd by this Change of Poſture? No, for their Bottoms would be at the ſame Diſtances, becauſe not removed; and their Tops, becauſe the ſame Line holds them, at the ſame Diſtances in both Poſtures.

Mr. *Bradley*'s Lines, drawn from the Trees below, which are one Perch aſunder, makes the two Rows of Trees, falſely, ſeem to be at equal Diſtances, becauſe theſe Lines are parallel to each other: But this is a Deceit; for, in Truth, the Diſtances of the Trees are not meaſured by the Diſtances of thoſe Lines, but by the extream Points at the Ends of the Lines; (1) and thoſe two Points above, where the Lines cut the Row obliquely, and at unequal Angles, are twice as far aſunder as the endmoſt or extream Points below are, where the Lines cut the Row at right Angles. Hence may be inferr'd, that there is Room for twice as many Trees to grow on the Hill as on the Baſe, and twice as much Grain for the ſame Reaſon, and becauſe there is twice the Surface for the Roots to ſpread in. And ſince Mr. *Bradley* allows the Hill to contain two Perches to one of the Baſe, and the Soil of both to be of equal Goodneſs, and yet, affirms, that the two can produce no more of Grain or Trees, than the one Perch can; I cannot ſee, why it ſhould not be as reaſonable to ſay, That two Quarters of Oats will maintain a Horſe no longer, nor better, than one Quarter of Oats, of equal Goodneſs, will do.

In *Page* 13. He concludes thus: ‘ That Hills in ‘ their Meaſure, contain only as much profitable ‘ Land as the Plain or Plat of Ground they ſtand up- ‘ on; and as a Proof of that, all *Vegetables* or *Plants* ‘ have an erect Method of Growth.

This Proof of Mr. *Bradley*'s is founded upon an Argument which has no Conſequence, unleſs it were firſt proved, that the Surface of Earth could produce and maintain as many *Vegetables* or *Plants* as could ſtand thereon in an erect Poſture; which Suppoſipoſition is as impoſſible, as that Half an Acre ſhould produce and maintain a Hecatomb, without Mr. *Bradley*'s teaching Oxen to live upon Air for their Food, as he thinks *Van Helmont*'s Tree did.

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(1) Theſe upper Trees are meaſured by the unequal Length of the Lines, not by their parallel Diſtance, as the lower Trees are; therefore his Meaſure is a Quibble.

All expert Husbandmen muſt needs be convinced, that the greateſt Crop of *Vegetables* that ever grew, might ſtand in an erect Poſture, upon a twentieth (and I may ſay the hundredth) part of the Surface that produced it; therefore there muſt be nineteen parts for the Roots to ſpread) unoccupied by the Trunks, Stems, or Stalks.

And tho' it be true, that a Hill will ſupport no more of theſe (than its Baſe) when placed in an erect Poſture cloſe together, as in a Sheaf; yet this cloſe Poſition is only proper for them when they are dead, and require no more Nouriſhment than Houſes and Pales do, and conſequently require no Room but to ſtand on. Therefore, this Argument of Mr. *Bradley*'s muſt not be admitted in VegetativeGrowth, where there is always required nineteen times more Room in the Surface, for the Uſe of the Roots, than what the Stems, Trunks, or Stalks, do poſſeſs upon it: And the more Room there is for the Roots, the greater Number of Plants may be produced.

Neither can I admit, that all *Vegetables* or *Plants* have an erect Method of Growth; becauſe the contrary is ſeen in Chamomile, and divers other *Vegetables*, which have an Horizontal Method of Growth.

But what is more material to this Purpoſe, to be obſerved, is, that all *Vegetables* have Horizontal Roots, and Roots parallel to the Earth's Surface or Superficies; and unleſs thoſe Roots have a ſufficient Superficies of Earth to range in, for Nouriſhment of a Plant, the Stem and Branches cannot proſper, whatever be their Method of Growth above the Earth; and if there be not a due Quantity of Food for the Roots, within the Earth, a very little Space may contain the external parts of *Vegetables* upon it.

From what has been ſaid, I think, we may conclude, that Mr. *Bradley*'s Hill may produce more *Vegetables* than the Baſe whereon it ſtands, and therefore it is of more Value than half its ſuperficial Meaſure, *i. e.* Two Acres on the Hill is worth more than one Acre on the Plain, the Soil being equally rich, as he allows it to be, in his Caſe.

Now, indeed, whether Mr. *Bradley* might not poſſibly be deceived in his Opinion, of the equal Richneſs of his Hill and his Plain, I will not diſpute; I will only ſay this, that 'tis generally otherwiſe. But where a Plain is plow'd up into moderate Ridges, their Heighth being in Proportion to the Depth of the Staple, below which the Plow muſt take nothing into the Ridges, the Soil is equally rich, whether it be plowed plain or ridged up. And as the Surface is in the Ridges increaſed, there is nothing, in all Mr. *Bradley*'s Arguments, that ſhews, why that increaſed Surface ſhould not produce more *Vegetables* than the ſame Earth could do whilſt it was level.

There are other Reaſons why it ſhould produce more when Ridged, beſides the Increaſe of Surface; as,

I. *'Tis then more free from the Injuries of too much Water.*

II. *'Tis better protected againſt cold Winds; becauſe the Ridges are a Shelter to one another.*

III. *If the Surface be much exhauſted, by too frequent Sowing, the Ridges may be made juſt where the Furrows were, and then the Surface will be intirely changed.*

The following general Rules ought to be obſerved about Ridges, *viz.*

That as to their Heighth, Regard muſt be had to the Nature of the Soil, in its difficult Admiſſion of Water; for the greater that is, the greater Declivities the Ridges ſhould have; and then, if the Soil be not deep, they ſhould generally be made the narrower.

There is one Thing which Mr. *Bradley* takes no Notice of, *viz.* That no more of the Rain, or other Benefits of the Atmoſphere, which deſcend perpendicularly, can fall on a Hill, or on a Ridge, than what would fall on the Baſe, or Ground Plot. But, 'tis probable, that more of the fine Vapour, which ſwims in the Current of the Air horizontally, does ſtrike and break againſt thoſe Eminences, and ſo make an Equivalent; (1) except that it runs off more quickly.

Notwithſtanding all I have here ſaid, in behalf of Ridges, I muſt confeſs, that for my *Hoeing-Husbandry*, I ſhould prefer Land that is naturally dry enough, without a Neceſſity of being laid up in any larger or higher Ridges than what may contain ſix Feet in Breadth, that Size being the largeſt that is proper for the regular Operation of the *Horſe-Hoe*; whether the Rows be double, treble, or quadruple.

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(1) But though Ridges do alter or increaſe the Surface, the Quantity of Soil or Earth remaining the ſame as on the Level, and of no greater Depth than can be Tilled, it may produce equal Crops of Corn with the Level, and no more; except from the Advantage the Ridges may give it in lying drier.

CHAP. XIX.

Of Differences *between the* Old *and the* New Husbandry.

IN order to make a Compariſon between the *Hoeing Husbandry*, and the *Old Way*, there are four Things; whereof the Differences ought to be very well conſidered.

I. *The Expence*
II. *The Goodneſs* } of a Crop.
III. *The Certainty*
IV. *The Condition in which the Land is left after a Crop.*

The Profit or Loſs ariſing from Land, is not to be computed, only, from the Value of the Crop it produces; but from its Value after all Expences of Seed, Tillage, &c. are deducted.

Thus when an Acre brings a Crop worth *four Pounds*, and the Expences thereof amount to *five Pounds*, the Owner's Loſs is *one Pound*; and when an Acre brings a Crop which yields *thirty Shillings*, and the Expence amounts to no more than *ten Shillings*, the Owner receives *one Pound* clear Profit from this Acre's very ſmall Crop, as the other loſes *one Pound* by his greater Crop.

The uſual Expences of an Acre of Wheat, ſown in the Old Husbandry, *in the Country where I live, is, in ſome Places, for two Buſhels and a half of Seed; in other Places four Buſhels and a half, the leaſt of theſe Quantities at* three Shillings per *Buſhel, being the preſent Price, is* ſeven Shillings *and* Six-pence. *For three Plowings, Harrowing, and Sowing,* ſixteen Shillings;

but if plow'd four times, which is better, one Pound. *For thirty Load of Dung, to a Statute Acre, is* two Pounds five Shillings. *For Carriage of the Dung, according to the Diſtance, from* two Shillings *to* Six-pence *the Load;* one Shilling *being the Price moſt common, is* one Pound ten Shillings. *The Price for Weeding is very uncertain, it has ſometimes coſt* twelve Shillings, *ſometimes* two Shillings per *Acre.*

	l.	*s.*	*d.*
In Seed and Tillage, nothing can be abated of - - - - -	01	03	06
For the Weeding, one Year with another, is more than - - - -	00	02	00
For the Rent of the Year's Fallow -	00	10	00
For the Dung; 'tis in ſome Places a little cheaper, neither do they always lay on quite ſo much; therefore abating 15 *s. in that Article, we may well ſet Dung and Carriage at* - - -	02	10	00
Reaping commonly 5 *s. ſometimes leſs* -	00	04	06
Total	04	10	00

Folding *of Land with Sheep is reckon'd abundantly cheaper than Cart-Dung; but this is to be queſtioned, becauſe much Land muſt lie ſtill for keeping a Flock (unleſs there be Downs) and for their whole Year's Keeping, with both Graſs and Hay, there are but three Months of the twelve wherein the Fold is of any conſiderable Value; this makes the Price of their Manure quadruple to what it would be, if equally good all the Year, like Cart-Dung: and Folding Sheep yield little Profit, beſides their Dung; becauſe the Wool of a Flock, except it be a large one, will ſcarce pay the Shepherd and the Shearers. But there is another Thing yet, which more enhances the Price of Sheep-Dung, and that is the dunging the Land with their Bodies, when* *they all die of the Rot, which happens too frequently in many Places; and then the whole Crop of Corn muſt go to purchaſe another Flock, which may have the ſame Fate the enſuing Year, if the Summer prove wet: And ſo may the Farmer be ſerved for ſeveral more ſucceſſive Years, unleſs he ſhould break, and another take his Place, or that dry Summer come in Time to prevent it. To avoid this Misfortune he would be glad to purchaſe Cart-Dung at the higheſt Price, for ſupplying the Place of his Fold; but 'tis only near Cities, and great Towns, that a ſufficient Quantity can be procured.*

But, *ſuppoſing the Price of Dunging to be only two Pounds ten Shillings, and the general expence of an Acre of Wheat, when ſown, at three Shillings per Buſhel, to be four Pounds ten Shillings, with the Year's Rent of the Fallow.*

The Expences of planting an Acre of Wheat in the *Hoeing Husbandry*, is three Pecks (1) of Seed, at *three Shillings per* Buſhel, is *two Shillings* and *three Pence.* The whole Tillage, if done by Horſes, would be *eight Shillings*; becauſe our two Plowings and ſix Hoeings, (2) are equal to two Stirrings, the common Price whereof is *four Shillings* each; but this we diminiſh half, when done by Oxen kept on St. Foin, in this manner, *viz.* Land, worth *thirty Shillings* Rent, drill'd with St. Foin, will well maintain an Ox a Year, (3) and ſometimes Hay will be left to pay for the making; we cannot therefore allow more than *one Shilling* a Week for his Work, becauſe his Keeping comes but to *Seven-pence* a Week round the Year.

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(1) Sometimes half a Buſhel is the moſt juſt Quantity of Seed to drill on an Acre.

(2) But we ſometimes plow our Six-Foot Ridges before Drilling, at five or ſix Furrows, which is a Furrow or two more than I have reckoned: But we do not always Hoe ſix times afterwards.

(3) Or an Ox may be well kept nine Months, with an Acre of indifferent *Horſe-hoed* Turneps; and if we value them only at the Expence and Rent of the Land, this will be a yet cheaper Way of maintaining Oxen.

In plain plowing, ſix Foot contains eight Furrows; but we plow a ſix-Foot Ridge at four Furrows, becauſe in this there are two Furrows cover'd in the Middle of it, and one on each Side of it lies open. Now, what we call one Hoeing, is only two Furrows of this Ridge, which is equal to a fourth part of one plain plowing; ſo that the Hoeing of four Acres requires an equal Number of Furrows with one Acre, that is plow'd plain, and equal time to do it in (except that the Land that is kept in Hoeing, works much eaſier than that which is not).

All the Tillage we ever beſtow upon a Crop of Wheat, that follows a Hoed Crop, is equal to eight Hoeings, two of which may require four Oxen each, one of them three Oxen, and the other five Hoeings two Oxen each. However allow three Oxen to each ſingle Hoeing, taking them all one with another, which is three Oxen more than it comes to in the whole.

Begin at five in the Morning; and in about ſix Hours you may Hoe three Acres, being equal in Furrows to three Rood, *i. e.* three Quarters of an Acre. Then turn the Oxen to Graſs, and after reſting, eating, and drinking two Hours and a half, with another ſet of Oxen begin Hoeing again; and by, or before half an Hour after Seven at Night, another like Quantity may be Hoed. Theſe are the Hours the Statute has appointed all Labourers to work, during the Summer Half-year.

To Hoe theſe ſix Acres a Day, each ſet of Oxen draw the Plow only eight Miles and a Quarter, which they may very well do in five Hours; and then the Holder and Driver will be at their Work of plowing

ing ten Hours, and will have four Hours and a half to reſt, *&c.*

The Expence then of Hoeing ſix Acres in a Day, in this manner, may be accounted; at *one Shilling* the Man that holds the Plow, *Six-pence* the Boy that drives the Plow, *one Shilling* for the ſix Oxen, and *Six-pence* for keeping the Tackle in Repair. The whole Sum for Hoeing theſe ſix Acres is *three Shillings*, being *Six-pence per* Acre (1), (2).

They who follow the *Old Husbandry* cannot keep Oxen ſo cheap, becauſe they can do nothing without the Fold, and Store-Sheep will ſpoil the St. Foin. They may almoſt as well keep Foxes and Geeſe together, as Store-Sheep and good St. Foin. Beſides, the ſowed St. Foin coſt ten times as much the planting as drill'd St. Foin does, and muſt be frequently manured, or elſe it will ſoon decay; eſpecially upon all ſorts of chalky Land, whereon 'tis moſt commonly ſown.

The Expence of Drilling cannot be much, for as we can Hoe ſix Acres a Day, at two Furrows on each ſix-Foot Ridge, ſo may we Drill twenty-four Acres a Day, with a Drill that plants two of thoſe Ridges at once; and this we may reckon a *Penny Half-penny* an Acre. But becauſe we find it leſs Trouble to drill ſingle Ridges, we will ſet the Drilling, at moſt, at *Six-pence per* Acre.

As every ſucceſſive Crop (if well managed) is more free from Weeds than the preceding Crop; I will ſet it all together at *Six-pence* (1) an Acre for Weeding.

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(1) But where there is not the Convenience of keeping Oxen, the Hiring Price of Hoeing with Horſes, is one Shilling each Time.

(2) When a Roller is uſed, which is leſs than a Hoeing, becauſe one Perſon to lead is enough, and that may be a Boy; and once in an Interval may ſuffice, then 'tis leſs Labour than half a Hoeing; and for this we may well abate one Hoeing of the eight.

For a Boy or a Woman to follow the *Hoe-Plow*, to uncover the young Wheat, when any Clods or Earth happen to fall on it, which Trouble is ſeldom neceſſary above once (2) to a Crop, *Two-pence* an Acre. *One Penny* is too much for Brine and Lime for an Acre.

Reaping this Wheat is not worth above half as much as the Reaping of a ſown Crop of equal Value; becauſe the Drill'd ſtanding upon about a ſixth part of the Ground, a Reaper may cut almoſt as much of the Row at one Stroke, as he could at ſix, if the ſame ſtood diſperſed all over the Ground, as the ſowed does. And becauſe he who reaps ſowed Wheat, muſt reap the Weeds along with the Wheat; but the drill'd has no Weeds; and beſides, there goes a greater Quantity of Straw, and more Sheaves, to a Buſhel of the ſowed, than of the drilled. And ſince ſome Hundred Acres of drilled Wheat has been reaped at *two Shillings* and *Six-pence per* Acre, I will count that to be the Price.

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(1) This is when the Land has been well cleanſed of Weeds in the preceding Crop, or Fallow, or both.

(2) But this Expence being ſo ſmall, 'tis better that a Perſon ſhould follow at every Hoeing where we ſuſpect that any Damage may happen from any Earth's falling on, or preſſing too hard againſt ſome of the Plants.

The whole Expence of an Acre of Drill'd Wheat.

	l.	s.	d.
For Seed - - -	00	02	03
For Tillage - - -	00	04	00
For Drilling - - -	00	00	06
For Weeding - - -	00	00	06
For Uncovering - - -	00	00	02
For Brine and Lime - -	00	00	01
For Reaping - - -	00	02	06
Total	00	10	00

The Expence of an Acre of Sow'd Wheat is - - - -	04	00	00
To which muſt be added, for the Year's Rent of the Fallow - -	00	10	00
Total	04	10	00

If I have reckon'd the Expence of the Drilled at the loweſt Price, to bring it to an even Sum, I have alſo abated in the other more than the whole Expence of the Drilled amounts unto.

And thus the Expence of a Drilled Crop of Wheat is but the ninth part of the Expence of a Crop Sown in the common Manner.

'Tis alſo ſome Advantage, that leſs Stock is required where no Store-Sheep are uſed.

II. *Of the different Goodneſs of a Crop.*

The Goodneſs of a Crop conſiſts in the Quality of it, as well as the Quantity; and Wheat being the moſt uſeful Grain, a Crop of this is better than a Crop of any other Corn, and the Hoed Wheat has larger Ears (and a fuller Body) than ſow'd Wheat. We can have more of it, becauſe the ſame Land will produce it every every Year, and even Land which, by the *Old Husbandry*, would not be made to bear Wheat at all: So that in many Places, the *New Husbandry* can raiſe Ten Acres of Wheat for One that the *Old* can do; becauſe where Land is poor, they ſow but a Tenth part of it with Wheat.

We do not pretend, that we have always greater Crops, or ſo great as ſome ſown Crops are, eſpecially if thoſe mention'd by Mr. *Houghton*, be not miſtaken.

The greateſt Produce I ever had from a ſingle Yard in Length of a double Row, was eighteen Ounces; the Partition of this being ſix Inches, and the Interval thirty Inches, was, by Computation, Ten Quarters (or Eighty Buſhels) to an Acre.

I had alſo twenty Ounces to a like Yard of a Third ſucceſſive Crop of Wheat; but this being a treble Row, and the Partitions and Interval being wider, and ſuppoſed to be in all ſix Foot, was computed to ſix Quarters to an Acre. And if theſe Rows had been better order'd than they were, and the Earth richer and more pulveriz'd, more Stalks would have Tillered out, and more Ears would have attain'd their full Size, and have equall'd the beſt, which muſt have made a much greater Crop than either of theſe were.

But to compare the different Profit, we may proceed thus: The Rent and Expence of a drill'd Acre being *one Pound*, and of a ſow'd Acre *five Pounds*; one Quarter of Corn produced by the drill'd, bears an equal Proportion in Profit to the *one Pound*, as five Quarters produced by the other do to the *five Pounds*. As ſuppoſe it be of Wheat, at *two Shillings* and *Six-pence* a Buſhel, there is neither Grain nor Loſs in the one nor the other Acre, though the former yield but One Quarter, and the other, Five; but if the drill'd Acre yield Two

Quarters, and the ſow'd Acre Four Quarters at the ſame Price, the drill'd brings the Farmer *one Pound* clear Profit, and the ſown, by its Four Quarters, brings the other *one Pound* Loſs. Likewiſe, Suppoſe the Drilling Farmer to have his *five Pounds* laid out on Five Acres of Wheat, and the other to have his *five Pounds* laid out on One dung'd Acre, then let the Wheat they produce be at what Price it will, if the Five Acres have an equal Crop to the One Acre, the Gain or Loſs muſt be equal. But when Wheat is *Cheap*, as we ſay it is, when ſold at *Two and Six-pence* a Buſhel, then if the *Virgilian* has Five Quarters on his Acre, he muſt ſell it all to pay his Rent and Expence; but the other having Five Quarters on each of his Five Acres, the Crop of One of them will pay the Rent and Expence of all his Five Acres, (1) and he may keep the remaining Twenty Quarters, 'till he can ſell them at *five Shillings* a Buſhel, which amounts to *forty Pounds*, wherewith he may be able to buy four of his five Acres at twenty Years Purchaſe, out of one Year's Crop, whilſt the *Virgilian* Farmer muſt be content to have only his Labour for his Travel; or if he pretends to keep his Wheat till he ſells it at *five Shillings* a Buſhel, he commonly runs in Debt to his Neighbours, and in Arrear of his Rent; and if the Markets do not riſe in time, or if his Crops fail in the Interim, his Landlord ſeizes on his Stock, and then he knows not how it may be ſold, Actions are brought againſt him, the Bailiffs and Attornies pull him to Pieces; and then the *Virgilian* Farmer is broke (1).

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(1) Or ſuppoſe a drill'd Acre to produce no more than one Third of the ſow'd Acre's Crop, whoſe Expence is five times as much as of the drill'd, 'tis much more profitable, becauſe a Third of Five Pounds, is One Pound Thirteen and Four Pence; and a Fifth of the Rent and Expence being only One Pound, ſuch drill'd Acre pays the Owner Thirteen and Four-pence more Profit than the other which brings a Crop treble to the drill'd.

III. *The Certainty of a Crop.*

The Certainty of a Crop is much to be regarded, it being better to be ſecure of a moderate Crop, than to have but a mere hazard of a great one. The *Virgilian* is often deceiv'd in his Expectation, when his Crop at coming into Ear, is very big, as well as when 'tis in Danger of being too little. Our Hoeing Farmer is much leſs liable to the Hazard of either of thoſe Extreams; for when his Wheat is big, 'tis not apt to lodge or fall down, which Accident is uſually the utter Ruin of the other, he is free from the Cauſes which make the *Virgilian* Crop too little.

A very effectual Means to prevent the falling of a Crop of Wheat, is to plow the pulveriz'd Earth for Seed early, and when 'tis dry. The early Seaſon alſo is more likely to be dry than the latter Seaſon is.

1. *The Virgilian is commonly late in his ſowing; becauſe he can't fallow his Ground early, for fear of killing the Couch, and other Graſs that maintains his folding Sheep, which are ſo neceſſary*
2. *to his Husbandry: And when 'tis ſow'd late, it muſt not be ſow'd dry, for then the Winter might*
3. *kill the young Wheat. Neither can he at that time plow dry, and ſow wet, becauſe he commonly ſows under Furrow; that is, ſows the Seed firſt, and plows it in as faſt as 'tis ſown. If he*

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(1) Tho' only five Acres and one Acre be put, yet we may imagine them Two hundred and fifty, and Fifty to enrich the one, or break the other Farmer.

4. *ſows early (as he may if he will) in light Land, he muſt not ſow dry, for fear the Poppies and other Weeds ſhould grow and devour his Crop;*
5. *and if his Land be ſtrong, let it be ſown early, wet or dry (tho' wet is worſt) 'tis apt to grow ſo ſtale and hard by the Spring, that his Crop is in danger of ſtarving, unleſs the Land be very rich, or much dung'd, and then the Winter and Spring proving kind, it may not be in leſs danger of being ſo big as to fall down and be ſpoil'd.*
6. *Another thing is, that though he had no other Impediment againſt plowing dry, and ſowing wet, 'tis ſeldom that he has time to do it in; for he muſt plow all his Ground, which is eight Fur-*
7. *rows in ſix Foot, and whilſt it is wet, muſt lie ſtill with his* Plow. *When he ſows under Fur-*
8. *row, he fears to plow deep, leſt he bury too much of his Seed, and if he plows ſhallow, his Crop loſes the Benefit of deep Plowing, which is*
9. *very great. When he ſows* upon Furrow *(that is after 'tis plow'd) he muſt harrow the Ground level to cover the Seed, and that expoſes the Wheat the more to the cold Winds, and ſuffers the Snow to be blown off it, and the Water to lie longer on it; all which are great Injuries to it.*

Our *Hoeing Husbandry* is different in all the forementi'd Particulars.

1. We can plow the two Furrows whereon the next Crop is to ſtand, immediately after the preſent Crop is off.

2. We have no uſe of the Fold, becauſe our Ground has annually a Crop growing on it, and it muſt lie ſtill a Year, if we would fold it, and that Crop would be loſt; and all the Good the Fold

could do to the Land, would be only to help to pulverize it for one ſingle Crop; its Benefit not laſting to the ſecond Year. And ſo we ſhould be certain of loſing one Crop for the very uncertain Hopes of procuring one the enſuing Year by the Fold; when 'tis manifeſt by the adjoining Crops, that we can have a much better Crop every Year, without a Fold or any other Manure.

3. We can plow dry, and drill wet, without any manner of Inconvenience.

4. *He fears the Weeds will grow and deſtroy his Crop:* We hope they will grow, to the end we may deſtroy them.

5. We do not fear to plant our Wheat early, (ſo that we plow dry) becauſe we can help the Hardneſs or Staleneſs of the Land by Hoeing.

6. The two Furrows of every Ridge whereon the Rows are to be drill'd, we plow dry; and if the Weather prove wet before theſe are all finiſh'd, we can plow the other two Furrows up to them, until it be dry enough to return to our plowing the firſt two Furrows, and after finiſhing them, let the Weather be wet or dry, we can plow the laſt two Furrows. We can plow our two Furrows in the fourth part of the Time they can plow their eight, which they muſt plow dry all of them, in every ſix Foot; for they can't plow part dry, and the reſt when 'tis wet, as we can.

7. We never plant our Seed under Furrow, but place it juſt at the Depth which we judge moſt proper, and that is pretty ſhallow, about two Inches deep, and then there is no danger of burying it.

8. We not only plow a deep Furrow, but alſo plow to the Depth of two Furrows; that is, we Trench-plow where the Land will allow it; and we have the greateſt Convenience imaginable for doing this, becauſe there are two of our Furrows al-

ways lying open; and two plow'd Furrows (that is one plow'd under another) are as much more advantageous for the nouriſhing a Crop, as two Buſhels of Oats are better than one for nouriſhing a Horſe. Or if the Staple of the Land be too thin or ſhallow, we can help it by raiſing the Ridges prepar'd for the Rows the higher above the Level.

9. We alſo raiſe a high Ridge in the Middle of each Interval above the Wheat before Winter, to protect it from the cold Winds, and to prevent the Snow from being driven away by them, and the Furrows or Trenches, from whence the Earth of theſe Ridges is taken, ſerve to drain off the Water from the Wheat, ſo that it being drier, it muſt be warmer than the harrow'd Wheat, which has neither Furrows to keep it dry, nor Ridges to ſhelter it, as every Row of ours has on both Sides of it.

IV. *The Condition in which the Land is left after a Crop.*

The different Condition the Land is left in after a Crop, by the one and the other Husbandry, is not leſs conſiderable than the different Profit of the Crop.

A Piece of eleven Acres of a poor thin chalky Hill, was ſown with Barley in the common manner, after a Hoed Crop of Wheat, and produced full five Quarters and a half to each Acre (reckoning the Tythe) which was much more than any Land in all the Neighbourhood yielded the ſame Year; though ſome of it be ſo rich, as that one Acre is worth three Acres of this Land: And no Man living can remember that ever this produced above half ſuch a Crop before, even when the beſt of the common Management has been beſtow'd upon it.

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A Field that is a ſort of a Heath Ground, us'd to bring ſuch poor Crops of Corn, that heretofore the Parſon carry'd away a whole Crop of Oats from it, believing it had been only his Tythe. The beſt Management that ever they did or could beſtow upon it, was to let it reſt two or three Years, and then fallow and dung it, and ſow it with Wheat, next to that with Barley and Clover, and then let it reſt again; but I cannot hear of any good Crop that it ever produced by this or any other of their Methods; 'twas ſtill reckon'd ſo poor, that no body cared to rent it. They ſaid Dung and Labour were thrown away upon it; then immediately after two ſown Crops of black Oats had been taken off it, the laſt of which was ſcarce worth the Mowing, it was put into the Hoeing Management, and when Three Hoed Crops (1) had been taken from it, it was ſown with Barley, and brought a very good Crop, much better than ever it was known to yield before; and then a good Crop of Hoed Wheat ſucceeded the Barley, and then it was again ſown with Barley, upon the Wheat Stubble; and that alſo was better than the Barley it uſed to produce.

Now, all the Farmers of the Neigbourhood affirm, that it is impoſſible but that this muſt be very rich Ground, becauſe they have ſeen it produce ſix Crops in ſix Years, without Dung or Fallow, and never one of them fail. But, alas! this different Reputation they give to the Land, does not at all belong to it, but to the different Sorts of *Husbandry*; for the Nature of it cannot be alter'd but by that, the Crops being all carried off it, and nothing added to ſupply the Subſtance thoſe Crops take from it, (except what Mr. *Evelyn* calls) the Celeſtial Influences, and that theſe are received by the Earth, in Proportion to the Degrees of its Pulveration.

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(1) Theſe Three Hoed Crops were of Turneps and Potatoes.

A Field was Drill'd with Barley after a Hoed Crop, and another adjoining to it on the ſame Side of the ſame poor Hill, and exactly the ſame Sort of Land, was drill'd with Barley alſo, part of it after the ſown Crop, the ſame Day with the other; there was only this Difference in the Soil, that the former of theſe had no manner of Compoſt on it for many Years before, and the latter was dunged the Year before, yet its Crop was not near ſo good as that which followed the Hoed Crop (2); tho' the latter had twice the plowing that the former had before Drilling, and the ſame Hoeings afterwards, *viz.* each was Hoed three times.

A Field of about ſeventeen Acres was Summer-fallow'd, and drill'd with Wheat, and with the Hoeing brought a very good Crop (except part of it, which being eaten by the treſpaſſing Sheep in the Winter, was ſomewhat blighted); the *Michaelmas* after that was taken off, the ſame Field was drilled again with Wheat, upon the Stubble of the former, and Hoed: This ſecond Crop was a good one, ſcarce any in the Neighbourhood better. A Piece of Wheat adjoining to it, on the very ſame Sort of Land (except that this latter was always reckoned better, being thicker in Mould above the Chalk) ſown at the ſame time on dung'd Fallows, and the Ground always dung'd once in three Years, yet this Crop fail'd ſo much, as to be judged, by ſome Farmers, not to exceed the Tythe of the other: That the Hoed Field has received no Dung or Manure for many Years paſt, is, becauſe it lies out of the Reach for carrying of Cart-Dung, and no Fold being kept on my Farm: But I cannot ſay, I think, there was

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(1) This was a Wheat Crop, and often well Hoed.

quite ſo much Odds betwixt this ſecond undung'd hoed Crop and the ſown; yet this is certain, that the former is a good, and the latter a very bad Crop.

I could give many more Inſtances of the ſame kind, where ho'd Crops and ſown Crops have ſucceeded better after ho'd Crops than after ſown Crops, and never yet have ſeen the contrary; and therefore am convinced, that the Hoeing (if it be duly perform'd) enriches the Soil more than Dung and Fallows, and leaves the Land in a much better Condition for a ſucceeding Crop; the Reaſon I take to be very obvious. The artificial Paſture of Plants is made and increaſed by Pulveration only; and nothing elſe there is in our Power to enrich our Ground, but to pulverize it, and keep it from being exhauſted by *Vegetables.* (1) (Superinductions of Earth are an Addition of more Ground, or changing it, and is more properly Purchaſing than Cultivating).

Their one Year's Tillage, *which is but two Plowings before Seed-time, commonly makes but little Duſt, and that which it does make, has but a ſhort time to lie expoſed for Impregnation; and after the Wheat is ſown, the Land lies unmoved for near twelve Months, all the while gradually loſing its Paſture, by ſubſiding, and by*

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(1) It may be asked, How 'tis poſſible that eight Hoeings, which are but equal, in Labour, to two plain Plowings, ſhould ſo much exceed three plain Plowings, as to procure as good or a better Crop without Manure, than the common three Plowings can do with Manure, and enrich the Land alſo?

The Anſwer is, That each Hoeing of the Five or Six being done to the Wheat Plants, tho' it does not clean plow the whole Interval underneath, yet it changes the whole external Superficies (or Surface) thereof, whereby it becomes impregnate by the Nitrous Air, as much as if it were all clean plowed at the time of every Hoeing, and the Weeds are as much ſtifled, or ſuffocated.

being continually exhauſted in feeding a treble Stock of Wheat Plants, and a Stock of Weeds, which are ſometimes a greater Stock. This puts the Virgilians *upon a Neceſſity of uſing of Dung, which is, at beſt, but a* Succedaneum *of the Hoe; for it depends chiefly on the Weather, and other Accidents, whether it may prove ſufficient by Fermentation to pulverize in the Spring, or no: And 'tis a Queſtion whether it will equal two additional (1) Hoeings, or but one; tho', as I have computed it, one Dunging coſts the Price of one hundred Hoeings.*

'Tis poſſible, perhaps, to pulverize the Ground with a Pen, and they ſeem to act almoſt as oddly, when, at ſuch a vaſt Expence, inſtead of a Hoe, they make Uſe of a T----, to help them in their Pulveration.

When they have done all they can, the Paſture, they raiſe, is generally too little for the Stock that is to be maintain'd upon it, and much the greateſt Part of the Wheat Plants are ſtarved; for from twenty Gallons of Seed they ſow on an Acre, they receive commonly no more than twenty Buſhels of Wheat in their Crop, which is but an Increaſe of Eight Grains for one: Now, conſidering how many Grains there are in one good Ear, and how many Ears on one Plant, we find, that there is not one Plant in ten that lives 'till Harveſt, even when there has not been Froſt in the Winter ſufficient to kill any of them; or if we count the Number of Plants that come up on a certain Meaſure of Ground, and count them again in the Spring, and likewiſe at Harveſt, we ſhall be ſatisfied, that moſt, or all of the Plants that are miſſing, could die by no other Accident than want of Nouriſhment.

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(1) *Additional*, becauſe there muſt firſt be ſeveral Hoeings to make our treble Row equal to an undunged Six-Foot Ridge of *ſown* Wheat.

They are obliged to ſow this great Quantity of Seed, to the end that the Wheat, by the great Number of Plants, may be the better able to contend with the Weeds; and yet, too often at Harveſt, we ſee a great Crop of Weeds, and very little Wheat among them. Therefore, this Paſture being inſufficient to maintain the preſent Crop, without ſtarving the greateſt part of its Plants, is likely to be leſs able to maintain a ſubſequent Crop, than that Paſture which is not ſo much exhauſted.

When their Crop of Wheat is much leſs than ours, their Vacancies (if computed all together) may be greater than thoſe of our Partitions and Intervals; theirs by being irregular, ſerve chiefly for the Protection of Weeds; for they cannot be plow'd out, without deſtroying the Corn, any more than Cannons firing at a Breach, whereon both Sides are contending, can kill Enemies, and not Friends.

Their Plants ſtand on the Ground in a confuſed manner, like a Rabble; ours like a diſciplin'd Army; we make the moſt of our Ground; for we can, if we pleaſe, cleanſe the Partitions with a Hand-Hoe (1); and for the reſt, if the Soil be deep enough to be drill'd on the Level, (2) in treble Rows, the Partitions at ſix Inches, (3) the Intervals five Foot; five Parts in ſix of the whole Field may be pulveriz'd every Year, and at proper times all round the Year.

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(1) Of all annual Weeds.

(2) This is only put as a Suppoſition; for I have for theſe ſeveral Years left off drilling on the Level, and do adviſe againſt it; becauſe altho' Mould ſhould not be wanting for the Partitions in deep rich Land, yet 'tis much more difficult to Hoe on the Level than on Ridges.

(3) But when 'tis drilled upon Ridges, the Proportion is leſs by how much the Partitions being thicker in Mould, contain more than a ſixth part of the whole ſix Foot of Earth, and the Proportion of unexhauſted Earth will be alter'd likewiſe; and I only mention theſe Diſtances to avoid Fractions.

The Partitions being one ſixth Part for the Crop to ſtand on, and to be nouriſhed in the Winter, one other ſixth Part being well pulveriz'd, may be ſufficient to nouriſh it from thence till Harveſt ; the Remainder, being two Thirds of the whole, may be kept unexhauſted, the one Third for one Year, and the other Third of it two Years, all kept open for the Reception of the Benefits deſcending from above, during ſo long a Time ; whilſt the ſowed Land is ſhut againſt them, every Summer, except the little time in which it is fallow'd, once in three Years, and a little, perhaps, whilſt they plow it for Barley in the Winter, which is a Seaſon ſeldom proper for pulverizing the Ground.

Their Land muſt have been exhauſted as well by thoſe ſupernumerary Plants of Wheat, while they lived, as by thoſe that remain for the Crop, and by the Weeds. Our Land muſt be much leſs exhauſted, when it has never above one third Part of the Wheat-Plants to nouriſh that they have, and generally no Weeds; ſo that our Hoed Land having much more Vegetable Paſture made, and continually renewed, to ſo much a leſs Stock of Plants, (1) muſt needs be left, by every Crop, in a much better Condition than theirs is left in by any one of their ſown Crops, altho' our Crops of Corn at Harveſt be better than theirs (2).

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(1) Therefore, whenever a Soil receives more Supplies of fine Earth from the Atmoſphere, than is exhauſted by all the Plants that grow in the Soil, it becomes richer ; but if the contrary, then it becomes poorer.

(2) On an undung'd low ſix Foot Ridge, we have three Rows eight Inches aſunder, all which being equal, during the Winter, but each of the two outſide Rows at Harveſt producing

They object againſt us, ſaying, That ſometimes the Hoeing makes Wheat too ſtrong and groſs, whereby it becomes the more liable to the Blacks (or Blight of Inſects); but this is the Fault of the Hoer, for he may chuſe whether he will make it too ſtrong, becauſe he may apply his Hoeings at proper times only, and apportion the Nouriſhment to the Number and Bulk of his Plants. However, by this Objection they allow, that the Hoe can give Nouriſhment enough, and therefore they cannot maintain that there is a Neceſſity of Dung (1) in the

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cing ten times as much Wheat as the middle Row doth, all three together produce a Quantity equal to one and twenty of this middle Row. Now, ſuppoſing the Roots of this Row not to reach through the outſide Rows, ſo as to receive any Benefit from the Hoed Intervals, then this Row might only be equal to one of nine Rows, which ſhould have been drilled eight Inches aſunder on this Ridge, and then our three would only be equal to twenty one of ſuch nine Rows. But ſince it can be demonſtrated, that the Roots of our middle Row do paſs through both the outſide Rows far into the Hoed Intervals, we may well ſuppoſe it to be at leaſt double to what it would have been, if it had had no Benefit from the Hoeing, and then our three will be equal to forty two of ſuch nine unho'd Rows. Thus our Crop is thirty three, in forty two (or almoſt four parts in five) increaſed by the Hoeing; for tho' many Fields of Wheat have been drilled all over in Rows eight Inches aſunder, it never has been judged in twenty Years Experience, that a Crop ſo planted, though not Hoed, was by its Evenneſs and Regularity, leſs, *Cæteris paribus*, than a Crop ſown at random.

(1) As for the Quantity of Vegetable Matter of Dung, when reduced to Earth by Putrifaction, it is very inconſiderable, and, of many Sorts of Manure, next to nothing.

The almoſt only Uſe of all Manure, is the ſame as of *Tillage*, *viz.* the Pulveration it makes by Fermentation, as *Tillage* doth by Attrition or Contuſion; and with theſe Differences, that Dung, which is the moſt common Manure, is apt to increaſe Weeds, as *Tillage* (of which Hoeing is chief) deſtroys them, and Manure is ſcanty in moſt Places, but *Tillage* may be had every where. Another Difference is, the vaſt Diſproportion of the Price of Manure and that of *Tillage*.

the *Hoeing Husbandry*; and that, if our Crops of Wheat ſhould happen to ſuffer, by being too ſtrong, our Loſs will be leſs than theirs, when that is too ſtrong, ſince it will coſt them nine times our Expence to make it ſo.

A ſecond Objection is, That as Hoeing makes poor Land become rich enough to bear good Crops of Wheat for ſeveral Years ſucceſſively, the ſame muſt needs make very good Land become too rich for Wheat. I anſwer, That if poſſibly it ſhould ſo happen, there are two Remedies to be uſed in ſuch a Caſe; the one is to plant it with Beans, or ſome other *Vegetables*, which cannot be over-nouriſhed, as Turneps, Carots, Cabbages, and ſuch like, which are excellent Food for fatting of Cattle; or elſe they may make Uſe of the other infallible Remedy, when that rich Land, by producing Crops every Year in the *Hoeing-Husbandry*, is grown too vigorous and reſty, they may ſoon take down its Mettle, by ſowing it a few Years in their *Old Husbandry*, which will fill it again with a new Stock of Weeds, that will ſuck it out of Heart, and exhauſt more of its Vigour, than the Dung, (1) that helps to produce them, can reſtore.

There is a third Objection, and that is, That the Benefit of ſome Ground is loſt where the *Hoe-Plow* turns at each End of the Lands; but this cannot be much, if any, Damage; becauſe about four ſquare Perch to a Statute Acre, is ſufficient for this Purpoſe, and that, at the Rate of *ten Shillings* Rent, comes to but *Three-pence*, tho' this varies, according

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Note. As we have no Way to enrich the Soil, but by Pulveration of Manure, or of Inſtruments, or of both; ſo Nature has ordain'd, that the Soil ſhall be exhauſted by nothing, but by the Roots of Plants.

(1) Dung made of the Straw of ſown Corn, generally abounds with the Seed of Weeds.

as the Piece is longer or ſhorter; and ſuppoſing the moſt to be eight Perch, that is but *Six-pence per* Acre; and that is not loſt neither, for whether it be of natural or artificial Graſs, the *Hoe-Plow* in turning on it, will ſcratch it, and leave ſome Earth on it, which will enrich it ſo much, that it may be worth its Rent for Baiting of Horſes or Oxen upon it. And beſides, theſe Ends are commonly near Quick-Hedges or Trees, which do ſo exhauſt it, that when no Cattle come there to manure it, 'tis not worth the Labour of Plowing it.

CHAP. XX. *Of PLOWS.*

BY what Means *Plows* and *Tillage* it ſelf came at firſt to be invented, is uncertain; therefore we are at Liberty to gueſs: And it ſeems moſt probable, that it was (like moſt other Inventions) found out by Accident, and that the firſt Tillers (or Plowers) of the Ground, were Hogs: Men in thoſe Days having ſufficient Leiſure for Speculation, obſerv'd, that when any Sort of Seed happen'd to fall on a Spot of Ground well routed up by the Swine, (whom Inſtinct had inſtructed to dig in Search of their Food) it grew and proſpered much better than in the whole unbroken Turf. This Obſervation muſt naturally induce rational Creatures to the Contrivance of ſome Inſtrument, which might imitate, if not excel Brutes in this Operation of breaking and dividing the Surface of the Earth, in order to increaſe and better its Product.

That ſome ſuch Accident gave Men the firſt Hints of *Original Agriculture*, may be inferred from the very little (or no) Probability of its being invented originally upon Arguments which might convince the Underſtanding (by juſt Concluſions from Ideas of the Earth and Vegetation) of any reaſonable Grounds to hope, that the Effect of increaſing the Earth's Produce, ſhould follow the *Cauſe of Tillage*; or, in other Words, Why it ſhould produce more when Tilled, than when Untilled. Therefore 'tis very unlikely that Men ſhould *Begin* to take Pains to Till the Land, without any ſort of Reaſon why they did it. And no ſuch Reaſon could they have, before the Invention, as they had afterwards. For when they *Accidentally* ſaw that *Effect* follow that *Cauſe*, then they were well convinced it did ſo. But tho' this Argument, *viz.* *Tillage*, increaſes the Product of the Earth, *becauſe it does*, has been ſufficient to continue the Practice of *Tillage* ever ſince; yet 'tis impoſſible for the Inventors to have had this Argument before the Invention, in caſe it had been invented by Men, and not fortuitouſly diſcover'd.

Had there ever been extant any other, or better Arguments whereon this Practice, ſo uſeful to Mankind, was founded; ſure, ſome of all the great and learned Authors, who have writ on this Subject, would have mention'd them. Philoſophers, Orators, and Poets have treated of it in the ſame Theory by which it was firſt diſcover'd, and by no other, *viz.* Land produces more when Tilled; and ſome ſeem to ſay, the more 'tis Tilled, the more it produces. It does, *becauſe it does*; not a Word of the Paſture of Plants, or any thing like it. So that all the ancient *Scriptores de re Ruſticâ* have done, was only to keep that Theory in the ſame Degree of Perfection in which the firſt Diſcoverers received it.

The briſtled Animals broke up the Ground, becauſe they uſed to find their Food there by digging; Men Till it, becauſe they find Tillage procures them better Food than Acorns.

The Reaſons are the ſame for one and the other.

Theſe Writers aſham'd to acknowledge ſo noble a Diſcovery to be owing to ſo mean a Foundation, make no mention of the true Teachers, but attribute the Invention to *Ceres*, (1) a Goddeſs of their own making ; ſhe, as they pretend, firſt taught the Art of *Tillage*. With this Fable they were ſo well pleaſed, that they never attempted to improve that Art, leſt they ſhould derogate from the Divinity of *Ceres*, in ſuppoſing her Invention imperfect.

With what Inſtrument Men firſt Tilled the Ground, we don't know exactly ; but there may be Reaſons to believe it was with the Spade, and probably a wooden one, and very rough.

For whilſt People liv'd on Acorns, there was no Uſe of the Smith, ſuch Food required no Knives for eating it, nor was it worth while to make Swords to fight for it ; and without Iron the Spade could not be well hewn, or ſhap'd ; but if it had been ſuch as it is at preſent, there never was any thing comparable to it, for the true Uſe of *Tillage*. Yet the Spade could not make that Expedition, which was neceſſary when *Tillage* became general in the Fields ; and therefore in time the Spade came wholly to be appropriate to the moſt perfect Sort of *Tillage* in the Garden. Then the Plow ſupply'd the place of the Spade in the Field ; and tho' it could not (ſuch as it was) Till the Land near ſo well, yet it could Till ten times more of it, and with leſs human Labour.

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(1) They did well indeed, to impute the Invention to a Woman ; becauſe the Reaſons whereon it was founded, were unbecoming of a Man : Being without Principles, it could not (likely) be improved, unleſs ſome Mathematical ones were diſcover'd.

They were very unjuſt, to give the Reputation of Inventrix of *Tillage* to *Ceres*, who could be no better than a Plagiary, and make poor *Cicely*, from whoſe Family ſhe ſtole it, fall as a Sacrifice to her Altar, as the *Porca Præcidanea* did, amongſt the *Romans*. But Swine had practiſed the Art of Turning the Soil, and ſo had Men, long before the fictitious Deity of *Ceres* was invented.

Why they did not improve the Plow, ſo that it might alſo Till as well as the Spade, ſeems owing to their primitive Theory, which gave no Mathematical Reaſon to ſhew wherein the true Method of *Tillage* did conſiſt, *viz.* in dividing the Earth into many Parts, to increaſe its internal Superficies, which is the Paſture of Plants.

The Difference betwixt the Operation of the Spade, and that of the common Plow, is only this: that the former commonly divides the Soil into ſmaller Pieces, and goes deeper.

How eaſy and natural it is to contrive a Plow that may equal the Spade, if not exceed it, in going deeper, and cutting the Soil into ſmaller Pieces, than the Spade commonly does, I leave to the Judgment of thoſe who have ſeen the Four-coulter'd Plow.

The Plow deſcrib'd by *Virgil* had no Coulter; neither do I remember to have ſeen any Coulter in *Italy*, or the South of *France*; and, as I have been inform'd, the Plows in *Greece*, and all the *Eaſt*, are of much the ſame Faſhion, neither is it practicable to uſe a Coulter in ſuch a Plow; becauſe the Share does not cut the Bottom of the Furrow horizontally, but obliquely; in going one way, it turns off the Furrow to the Right Hand, but in coming back, it turns it to the Left; therefore, if it had a Coulter, it muſt have been on the wrong Side every other Furrow: And beſides, as the Handle (for it has but one) always holds the Plow towards one Side, with the Bottom of the Share towards the unplow'd Land, it would cauſe the Coulter to go much too low when it went on the Furrow Side, and it would not touch the Ground, when it went on the Land Side.

'Tis a great Miſtake in thoſe, who ſay, *Virgil's* Plow had two Earth-Boards, for it had none at all; but the Share it ſelf always going obliquely, ſerv'd inſtead of an Earth-Board, and the two Ears which were the Corners of a Piece of Wood lying under the Share, did the Office of Ground-Wreſts: This Faſhion continues to this Day in thoſe Countries, and in *Languedoc.*

This Sort of Plow performs tolerably when Ground is fine, and makes a ſhift to break up light Land; and I could never find any other Land there: I am ſure, none comparable to ours for Strength; and it would be next to impoſſible, to break up ſuch as we in *England* call *Strong Land*, with it.

I do not find, that the Arable Lands about *Rome* are ever ſuffered to lie ſtill long enough to come to a Turf; but I have obſerv'd in the low rich Lands in the *Calabria's*, ſubject to the Invaſions of the *Turks*, that there is Turf, and that theſe Plows go over the Land two or three times before the Turf of it is all broken, tho' the Soil be a very mellow ſort of Garden-Mould. Having no Coulters to cut it, they break and tear the Turf into little Pieces. This was done in the Month of *November*; and had I not ſeen Men and Oxen at the Work, or had there been Oaks in the Place, I ſhould rather have thought that Tillage perform'd by a Race of the firſt Teachers of it, in muzzling Acorns than by Plows. However, the Mould being naturally very mellow, when the Turf is broken with ſhallow Plowing, they can plow deeper afterwards.

The *Engliſh* Plows are very different from the *Eaſtern*, as in general the Soil is.

Theſe, when well made, cut off the Furrow at the Bottom horizontally; and therefore, it being as thick on the Land Side, as on the Furrow Side, the Plow cannot break it off from the whole Land, at ſuch a Thickneſs (being ſix-times greater than the *Eaſtern* Plows have to break off), and muſt of Neceſſity have a Coulter to cut it off; by this means the Furrow is turn'd perfectly whole, and no part of the Turf of it broken; and if it lie long without new Turning, the Graſs from the Edges will ſpread and form a new Turf (or Swerd) on the other Side, which was the Bottom of the Furrow before Turning, but is now become the Surface of the Earth, and may ſoon become greener with Graſs than before plowing; and often the very Roots ſend up new Heads to help ſtock the reverſed Furrow, the former Heads being converted into Roots, ſo that 'tis doubly cloathed and braced on both Sides, or, as it were, kay'd together, firm and ſolid, almoſt as a Plank; it may be drawn from one Side of a Field to the other, without breaking, and might poſſibly be made uſe of, inſtead of *Virgil's Crates Viminea*, for harrowing or ſmoothing of fine Till'd Ground; but not without much Time, Labour, and Difficulty can it be made ſuch it ſelf.

If you plow whole ſtrong turfy Furrows croſsways, as *Virgil* directs, and as it is too commonly practiſed, the Coulter cannot eaſily cut them, becauſe, being looſe underneath, they do not make a ſufficient Reſiſtance or Preſſure againſt its Edge, but move before it, and ſo are apt to be drawn and driven up into Heaps, with their Surfaces lying all manner of ways, and ſituate in all manner of Poſtures: So the Turf, which is not turned, continuing in the open Air, grows on, and with its vigorous Roots, holds the Earth faſt together, and will not ſuffer the neceſſary Diviſion to be made, which would be, if the Turf were rotten, and which is the

End of all Tillage, *viz.* to increaſe the Paſture of Plants.

Next, ſome have vaſt heavy Drags, with great long Iron Tines in them; and tho' theſe huge broken Pieces of Furrows being looſer than before, require keener Edges to cut them; yet theſe Drag-Tines have no Edge at all, but are as blunt as the Furrows they ſhould cut. Theſe Drags draw them ſometimes into larger Heaps, leaving the *Under-Stratum* bare betwixt them, only ſhaking off ſome of their Mould in tumbling them about, and ſcratching their Surfaces, without reducing them to a moderate Fineneſs, until this ill-broken Land has, for above a Year, and ſometimes longer, entertained Plows, Cattle, and Men, with a frequent laborious Exerciſe, for which they are obliged to the one Coulter.

If the Soil be ſhallow, it may be broke up with a narrow Furrow, which will the ſooner be brought in Tilth; but if it be a deep Soil, the Furrows muſt be proportionably large, or elſe a Part of the good Mould muſt be left under unmoved, and ſo loſt; for a narrow Furrow cannot be plowed deep, becauſe the Plow will continually ſlip out from the hard Land toward the Right-hand, unleſs the riſing Furrow be of ſufficient Weight to preſs the Plow towards the Left, and keep it in its Work: The deeper you plow, the greater Weight is required to preſs it; ſo that the deeper your Land is, the worſe (or into the larger Furrows) muſt it be broke up with one Coulter, inſomuch, that if the Land be ſtrong, (as moſt deep Ground in *England* is) 'tis a Work of ſome Years to conquer it, after it has been reſted. And often it happens, that the exceſſive Charge of this Tillage reduces the Profit of rich Land below that of poor.

This gives an Opportunity to deceitful Servants, of impoſing upon their ignorant Maſters. They plow ſuch deep Land with a ſmall ſhallow Furrow, to the End the Turf and Furrows may be broken, and made fine the ſooner; pretending they will plow it deeper the next time (which is called Stirring) which theſe Rogues know very well cannot be done, and intend no more than that, the Plow coming the eaſier after the Horſes, their Coats may ſhine the better, and tho' there be no Crop at Harveſt, they muſt have four Meals a Day, all the Year, and extravagant Wages at *Michaelmas*, or at any time of the Year, when they think fit to misbehave themſelves.

This Sort of Land muſt not be ſtirred, *i. e.* plowed the ſecond time in wet Weather, for that will cauſe the Graſs and Weeds to multiply, beſides the treading the Ground into hard Dabs, &c. And in dry Weather, the Plow will never enter any deeper than it went the firſt time, the Reſiſtance below being ſo much more than the Preſſure above, the Plow will riſe up continually; or if it goes deep enough for the Weight of Earth to keep it down, another Inconvenience will follow, which is that mention'd by *Columella, pag.* 47. *Quod omnis humus quamvis lætiſſima, tamen inferiorem partem jejuniorem habet, eamque attrahunt excitatæ majores Glebæ; quo evenit, ut infæcundior materia miſta pinguiori ſegetem minus uberem reddat.* The vulgar *Engliſh* Phraſe is, It *Spaults* up from below the Staple. Hence the treacherous Plowman is ſecure of an eaſy Summer's Work, if he can perſwade his Maſter to ſuffer him to fallow the Ground with a ſhallow Furrow.

Another way to conquer a ſtrong Turf, is, to plow it firſt with a Breaſt-Plow, very thin; and when the Swerd is rotten, then plow it at the proper Depth: But this Method is (beſides the extraordinary Charge of it) liable to other great Misfortunes. If the Turf be pared up in Winter, or early in the Spring, 'tis a Chance but the Rains cauſe it to grow ſtronger than before, inſtead of its Rotting.

And if it be pared later, tho' dry Weather do follow, and continue long enough to kill the Turf, yet this loſes Time, the Seaſon of plowing is retarded, for all the Staple ſtill remains untill'd, and before that can be well done, the Year is too far ſpent for ſowing it with Wheat, which is the moſt proper Grain for ſuch ſtrong Land, (1) and few will have Patience to wait, and plow on till another Wheat Seed Time. The dry Weather alſo, which in Summer kills the Swerd, renders the plowing obnoxious to moſt or all the Evils aforemention'd.

A Farmer enquires concerning the *Four Coulter Plow*, as in the following *Dialogue*.

Farm. *What muſt we do then? Muſt we have Recourſe to the Spade for breaking up our rich, ſtrong, ſwerdy Land?*

Reſp. If you can procure Men to dig it faithfully in Pieces, not above two Inches and a half thick, at the Price of about eight Shillings *per* Acre, it would do very well, and anſwer all the Ends of Tillage; but tho' you bargain with them to dig it at that Size for three Pounds *per* Acre, you will find, upon Examination, moſt of the Pieces or Spits, which are dug out of your Sight, to be of twice that Thickneſs, and no great Quantities can be this way managed, although the Price of Corn ſhould anſwer ſuch an extravagant Expence.

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(1) Beſides, moſt ſtrong Land has Stones in it, which will not admit the Uſe of the *Breaſt-Plow*.

Farm. *Since 'tis ſo difficult to bring our ſtrong Land into Tilth, after it has reſted, that it cannot be ſpeedily done by a Plow without a Coulter, or by one with a Coulter, in wet Weather or dry, nor with a* Breaſt-Plow, *without a certain Expence, and an uncertain Succeſs, the Spade is too chargeable a Tillage for the Field: It ſeems to me, upon the whole, that we are Loſers by this* Inaratæ gratia Terræ, *unleſs we could contrive ſome other Method of reducing it ſooner, and with leſs Charge, into Tilth; for, I obſerve, that when we ſow it upon the Back, the Corn and Graſs (or Couch) coming both together, exhauſt the Ground ſo much, that by that time we can (which is about three Years) reduce the great Lumps to a tolerable Fineneſs, it grows full of Graſs and Weeds (which we call Foul) and loſes that Fertility we expected it ſhould acquire by Reſt, becoming, in our Terms, both out of Tilth and out of Heart.*

Reſp. If you know all this to be true, and that, without a Coulter you cannot break it up at all; and that, with one Coulter you cannot any way cut the Furrow ſmall enough, or leſs than ten Inches broad; why do not you cut it with four Coulters, which will reduce the ſame Furrow into four equal Parts, of two Inches and a half each in Breadth, and of the Depth of the Staple, tho' that ſhould be two Spit, or ſixteen Inches deep.

Farm. *How can that be done?*

Reſp. Every Jot as eaſily as with one Coulter. For before the Furrow is rais'd by the Share, it lies faſt, and makes a ſufficient Reſiſtance equally againſt the Edges of all the Coulters, tho' after it be rais'd and looſe, it yields and recedes every way, except downwards, ſo that it cannot be cut by any Edge, but ſuch as attacks it perpendicularly from above, as that of the Spade does.

Farm. *This ſeems, to me, reaſonable, and having very lately heard Talk of this Plow, I would gladly know more of it.*

Reſp. The Furrow being cut into four Parts, has not only four times the Superficies on the eight Sides, which it would have had on two Sides; but it is alſo more divided croſs-ways, *viz.* The Ground-wreſt preſſes and breaks the lower (or Right-hand) Quarter; the other three Quarters in riſing and coming over the Earth-board, muſt make a crooked Line about a Fourth longer than the ſtrait one they made before moved; therefore, their Thinneſs not being able to hold them together, they are broken into many more Pieces, for want of Tenacity to extend to a longer Line, contrary to a whole Furrow, whoſe great Breadth enables it to ſtretch and extend from a ſhorter to a longer Line, without breaking, and as it is turn'd off, the Parts are drawn together again by the Spring of the Turf or Sward, (1) and ſo remain whole after Plowing. Thus the Four-Coulter'd Plow can divide the Soil into above twenty times more Parts than the common Plow; and ſometimes when the Earth is of a right Temper betwixt wet and dry, the Earth-board, in turning Furrows off, will break them into Duſt, having more Superficies than is made by four common Plowings; and it is impoſſible there ſhould be any large Pieces amongſt it.

Now, What a prodigious Advantage muſt the Influences of the Atmoſphere have upon theſe ſmall Parts, for making a further Diviſion of them? Froſt, Water, Drought, and nitrous Air eaſily penetrate to their very Centers, which cannot in the largeſt of them be more than one Inch and a quarter diſtant from their Superficies. This Advantage, with a few ſubſequent common Plowings perform'd in proper Seaſons, reſolves the Earth almoſt all to a Powder. The Swerd, ſome being immers'd or bury'd and mix'd among ſo great a Proportion of Mould, is ſoon rotten and loſt, ſome of the Swerd lying looſe a-top, the Earth preſently drops out of it, and then the Roots are dry'd up, and die. Thus is the whole Staple of the Ground brought into perfect Tilth in a very ſhort Time beyond what the Spade ever does in ſuch ſwerdy Land.

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(1) A ſwerdy Furrow cut off by only one Coulter, being whole, is apt to ſtand up on its Edge, or lie hollow, and then being open to the Air, it does not rot; but when it is cut by ſeveral Coulters, it has not Strength to ſupport it ſelf, it falls down, lies cloſe to the Earth under it, and excluding the free Air from the Turf, it ſoon becomes rotten.

Farm. *What Sort of Weather is beſt for uſing this Plow?*

Reſp. Any Weather, except the Ground be ſo dry and hard, that the Plow cannot enter it; but 'tis very proper to be done, when the Earth is ſo wet, that by no means it ought to be plowed with any other Plow; for it never can be too moiſt for this, unleſs the Cattle which draw it, be mired: becauſe, tho' all the Cattle ſhould not go in the Furrow, yet their Treadings are cut ſo ſmall by the Coulters, that the Earth is not kept from diſſolving, as when turn'd off whole in common Tillage. 'Tis obſerv'd, that the Inciſions made by the Coulters on ſwerdy Land, will not heal or ſo cloſe up, but that they will open again by the next plowing, tho' it be a great while after. A Farmer who uſes this Plow, may Till in all Weathers and all Seaſons of the Year, either in Fallowing with this, which is beſt in wet, or in ſtirring with the common ones, which muſt be done in dry Weather (1); and when the Ground is broke up with this, it may be ſtirr'd in the drieſt Weather that can be, without the Danger of tearing (or ſpaulting) up of the *Under-Stratum* along with the Staple, becauſe this is all broken before, and then no more can riſe with it; as it does to the Ruin of the Soil, when in common Tillage they go deeper the ſecond time than the firſt; alſo, if there be a Neceſſity of ſtirring ſome Sort of Land when 'tis wet, it ought either to be done with this Plow, or elſe with a common one drawn by a ſingle Row of Cattle treading all in the Furrow: For tho' ſome Land be very fine, yet, when plow'd by a double Row of Cattle in wet Weather, it will be made into large Pieces by the treading, and perhaps not diſſolve again in a long time, therefore 'tis better to be prevented.

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(1) In this Way of plowing, there is no need to obſerve the critical Day of the Moon, nor whether ſhe be increaſing or de-

Farm. *I perceive this Plow lays the Foundation for all good Husbandry; and there can be no other way to bring Land into perfect Tilth in ſo ſhort a Time, or with ſo little Expence. And I am convinc'd, that no Farmer ought to be without it, who deſires to be free from the Danger of his Land being ever out of Tilth; but I have heard it objected, that it is harder to draw than the common Plows: And that its Beam being longer, upon account of the four Coulters, it lies farther behind, and comes harder after the Horſes.*

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decreaſing, neither what Wind blows, as *Virgil* ſo dogmatically enjoins to be preciſely obſerved; and ſome of the Ancients preſcribe the very Hour of the Day, beſides innumerable Degrees of wet and dry Weather, ſo that without all theſe Accidents meet, they tell us we muſt abſtain from plowing. Our Plowmen would be glad their Maſters were as ſuperſtitious, for then the Plow might keep Holydays enough. But far from all this, we do not even obſerve at what time of the Sun's Courſe we Till our Land, and find it always ſucceeds beſt when the Soil can be broken into moſt Parts, without having any other Regard to Sun, Moon, Wind or Weather: This Plow prevents the Injuries of them all.

Reſp. I muſt confeſs, there is ſomething in that Objection; for this Plow being ſomething longer, may be a little the harder Draught, and alſo its Weight and Strength muſt bear a Proportion to the Length of it. But this ſmall Increaſe of the Draught would have been a much ſtronger (if not a fatal) Objection, had that Cuſtom been general, of Horſes drawing by their Tails, as 'tis ſaid to have been formerly in ſome Places; for then, perhaps, a ſufficient Strength of Horſes could not be apply'd to the Plow. But in Countries where Traces are in Uſe, every Horſe of the Team may draw the Plow equally, and then there will be no other Inconvenience, beſides the adding one Horſe, or keeping a ſtronger Team: And he cannot be wiſe, who would loſe the Profit of his Land, for the odds of ſometimes adding a Horſe to his Plow. And I am very certain, that this Plow requires a much leſs Strength of Cattle to draw it, in moiſt Weather, which is the moſt proper to uſe it in, than to draw a common Plow in the ſame Ground, and at the ſame Depth, in dry Weather; and can ſeldom be uſed ſafely in any other. And the Vulgar, who have always a wrong Cauſe ready at hand to apply to every thing, impute that Draught to the Faſhion of the Plow, which ought to be imputed to its going deeper; and this great Depth at which 'tis capable of Plowing, *viz.* Two Spit deep is one extraordinary Benefit of it, tho' it may, on Occaſion, go as ſhallow as any.

The Draught is not ſo much increaſed by adding three Coulters, as may be imagined; for when the Ground is moiſt, the Inciſions are eaſily made by the Edges; and when they are cut ſmall, the Furrows riſe much more eaſily upon the Share and Earth-Board, than if whole.

Farm. *If this Plow be ſo beneficial, having ſo many Ad-*

Advantages, and only the two Inconveniencies, one of requiring a little more Strength to draw it, and the other its being unfit for dry hard Ground, I wonder why it is not become more Common?

Reſp. It has been uſed with very great Succeſs for theſe ſeveral Years laſt paſt, but never like to be Common, unleſs it be deſcribed in a more Geometrical Manner, than any Plow has hitherto been; for the Plow-wrights find it difficult enough to make a common Plow with one Coulter to perform as it ought, for want of the neceſſary Rules of their Art. 'Tis upon this Account that the two-coulter'd Plows are uſed in few Places, though they have been found of excellent Uſe, and have been formerly common: But, alas! when the Makers, who by their diligent Study and much Practice had attained the Perfection of their Art, for want of Learning to write their Rules mathematically, and ſhow how the mechanical Powers were applicable to them, the Art was in a manner loſt, at the Death of thoſe Artiſts; and then the unskilful Plow-wrights, deſtitute of the true Rules, were not able to make a two-coulter'd Plow to perform well, and then it was left off. Very lately 'tis revived, ſince the three and four-coulter'd ones have been uſed; from whence ſome have made a ſhift to take the Rules of placing two Coulters into a Plow, and they begin to be common again; and, no doubt, will ceaſe again as ſoon as the Rules are forgot.

'Tis ſtrange that no Author ſhould have written fully of the Fabrick of Plows! Men of greateſt Learning have ſpent their Time in contriving Inſtruments to meaſure the immenſe Diſtance of the Stars, and in finding out the Dimenſions, and even Weight of the Planets: They think it more eligible to ſtudy the Art of plowing the Sea with Ships, than of Tilling the Land with Plows; they beſtow the utmoſt of their Skill, learnedly, to pervert the natural Uſe of all the Elements for Deſtruction of their own Species, by the *Bloody* Art of War. Some waſte their whole Lives in ſtudying how to arm Death with new Engines of Horror, and inventing an infinite Variety of Slaughter; but think it beneath Men of Learning (who only are capable of doing it) to employ their Learned Labours in the Invention of New (or even improving the Old), Inſtruments for increaſing of Bread.

The eaſieſt Method of perpetuating the Uſe of the many-coulter'd Plows, and other newly-invented Inſtruments of *Husbandry*, is by Models, *i. e.* the Things themſelves in Little, and theſe may be all portable even in a Man's Pocket: Every Part muſt be fully deſcribed, with the true Dimenſions, and the Mathematical Reaſons on which their Contrivance is founded: Directions alſo for uſing them muſt be given at the ſame time that their Manner of Making is deſcrib'd. In ſome the very Horſes which draw, muſt be repreſented, to ſhew the Manner of fixing the Horſes and the Traces: Cautions againſt all the Errors that may happen by the want of Experience in the Makers or Uſers, muſt be given.

When this is done, and the Rules put into a Method, the *New Hoeing Husbandry*, in all its Branches, will be much more eaſy and certain than the *Old*; becauſe there are no Mathematical Rules extant in any Method; and a Man may practiſe the old random Husbandry all his Life, without attaining ſo much Certainty in *Agriculture* as may be learn'd in a few Hours from ſuch a Treatiſe.

The Rules, indeed, require much Labour, Study, and Experience to compoſe them; but when finiſh'd, will be moſt eaſy to practiſe: Like the Rules for meaſuring Timber; their Uſe is, at firſt Sight, eaſy to every Carpenter, and to moſt Artificers who work in Wood, but no illiterate Perſon is able to compoſe thoſe Rules, or to meaſure Timber without them.

Chap. XXI. *The Deſcription of a* Four-Coulter'd Plow.

TO deſcribe all Parts of a Plow Geometrically, would require more Time and Learning than I am Maſter of; therefore leaving that to be done by ſome-body elſe, who is better qualified for it, I ſhall at preſent attempt little more than what relates to the three added Coulters.

In *Plate* 1. *Fig.* 1. is the Portrait of a common Two-Wheel'd-Plow uſed in *Berkſhire*, *Hampſhire*, *Oxfordſhire*, and *Wiltſhire*, and in moſt other Counties of *South-Britain*; and is generally eſteemed the beſt Plow for all Sorts of Land, except ſuch miry Clays that ſtick to the Wheels, and clog them up, ſo as they cannot turn round.

But they have in ſome Places, a Contrivance to prevent this Inconvenience; which is done, by winding Thumb-Ropes of Straw about the Iron Circles of the Wheels, and about the Spokes. The Wheels preſſing againſt the Ground, the Thumb-Ropes are diſtended on each Side; which Motion throws off the Dirt, and prevents its ſticking to the Wheels, which it would otherwiſe do.

'Tis commonly divided into two Parts, *viz.* the *Plow-Head*, and the *Plow-Tail.*

The Pow-Head contains the two Wheels A, B, *Fig.* 1. and their Axis or Spindle of Iron paſſing thro' the Box C, turning round both therein, and in the Wheels; the two Crow-Staves D, D, faſtned into the Box perpendicularly, and having in each, two Rows of Holes, whereby to raiſe or ſink the Beam, by pinning up or down the Pillow E, to increaſe or diminiſh the Depth of the Furrow; the Gallows F, thro' which the Crow-Staves paſs at top, by Mortiſes, into which they are pinned; G the Wilds with its Links and Crooks of Iron, whereby the whole Plow is drawn; H the Tow-Chain which faſtens the Plow-Tail to the Plow-Head, by the Collar I at one End, and by the other End paſſing through a Hole in the Middle of the Box, is pinned in by the Stake K; L the Bridle-Chain, one End whereof is faſtened to the Beam by a Pin, and the other End to the Top of the Stake, which Stake is held up to the left Crow-Staff, by the With M, paſſing round it above, and under the End of the Gallows below; or inſtead of this With, by a piece of Cord, and ſometimes by the End of the Bridle-Chain, when that is long enough.

The Plow-Tail conſiſts of the Beam N; the Coulter O; the Share P; and the Sheat Q; the Hinder-Sheat R, paſſing thro' the Beam near its End; S the ſhort Handle, faſtened to the Top of the Hinder-Sheat by a Pin, and to the Top of the Sheat by another Pin; T the Drock which belongs to the right Side of the Plow-Tail, and whereto the Ground-Wriſt V is faſten'd; as is the Earth-Board, whoſe Fore-part W, *Fig.* 3. is ſeen before the Sheat; and alſo the long Handle X, whoſe Fore-part Y appears before the Sheat, and is faſten'd to the Drock by a Pin at a, the other End of which Pin, goes into to the Beam. *Z* is the double Retch, which holds up the Sheat, and paſſes through the Beam to be faſten'd by its Screws and Nuts at b and c.

But without intrenching much farther upon the common Plow-Wright's Art, whoſe Trade is his Living, I'll haſten to ſhew the neceſſary Difference there is betwixt the *Common Plow*, and the *Four-Coulter Plow*, beginning with *Fig.* 2. where it is repreſented as ſtanding upon a level Surface.

Fig. 2. And, *Firſt*, The Beam differs in Length, being ten Foot four Inches long, as the other Plow-Beam is but eight Foot; it differs in Shape, as the other is ſtreight from one End to the other, but this is ſtreight only from a to b, and thence turns up of a ſudden, in the Manner that is ſhewn in the Cut; ſo that a Line let down perpendicular, from the Corner at a, to the even Surface whereon the Plow ſtands, would be eleven Inches and a half, which is its Height in that Place; and if another Line were let down, from the turning of the Beam at b, to the ſame Surface, it would be one Foot eight Inches and a half, which is the Height that the Beam ſtands from the Ground, at that Part; and a third Line let down to the Surface, from the Bottom of the Beam, at that Part which bears upon the Pillow, will ſhew the Beam to be two Foot ten Inches high above the Surface in that Part.

From the End a, to the Back-part of the firſt Coulter, is three Foot two Inches; from thence to the Back of the next Coulter, is thirteen Inches; thence to the third, thirteen Inches; and from thence to the fourth, the ſame. From a to b is ſeven Foot.

This Crookedneſs of the Beam is to avoid the too great Length of the foremoſt Coulters, which would be neceſſary if the Beam was ſtreight; and then, unleſs they were vaſtly thick and heavy, they would be apt to bend, and the Point of the fourth would be at ſo great a Diſtance from its Coulter-Hole, that it would have the greater Power to looſen the Wedges, whereby the Coulter would riſe up out of its Work, as it never doth when the Beam is made in this bending manner. This Beam is made either of Aſh, which is the lighteſt, or of Oak, which is the moſt durable. Its Depth and Breadth may vary, according to the heavier or lighter Soil it is to till; but this before us is in Depth five Inches at the firſt Coulter-Hole, and in Breadth four Inches.

Fig. 4. Is the Sheat Q in *Fig.* 1. (broad ſeven Inches) with the Iron Retch on it, the left Leg of which Retch muſt ſtand foremoſt, to the end that the Edge of its Fore-part, that is flat, may ſit cloſe to the Wood of the Sheat: This Retch holds the Sheat faſt up to the Beam by its Nuts and Screws; as alſo does a Pin driven into the Hole a, which Hole being a ſmall part of it within the Beam, the Pin being driven into the Hole, draws up the Sheat very tight to the Beam. The principal Thing to be taken Notice of here, is the Angle b c d, which ſhews the Elevation of the Sheat; the Line c d is ſuppoſed to be equal with the Bottom of the Share, (or rather with the plain Surface whereon it ſtands;) when this Angle at c is larger than of forty five Degrees, a common Plow never goes well: In my *Four-Coulter Plow* I chooſe to have it of forty two, or forty three at the moſt.

Fig. 5. Is the Share; a is the End of the Point; b is the Tail of the Share, long from a to b three Foot nine Inches; c the Fin; d the Socket into which the Bottom of the Sheat enters; e a thin Plate of Iron riveted to the Tail of the Share: By this Plate, the Tail of the Share is held to the hinder Sheat, as at d; in *Fig.* 1. by a ſmall Iron Pin with a Screw at its End, and a Nut ſcrew'd on it on the inner or right Side of that Sheat. From a to f is the Point, long about three Inches and a half, flat underneath, and round at Top: It ſhould be of hard Steel underneath. From f to c is the Edge of the Fin, which ſhould be well ſteeled; the Length of it is uncertain, but it ſhould never make a leſs Angle at f than it appears to make in this *Fig.* The Socket is a Mortiſe of about a Foot long, at the upper part; two Inches deep: The Fore-End of this Mortiſe muſt not be perpendicular, but oblique, conformable to the Fore-part of the Sheat which enters it; the upper Edge of which Fore-part muſt always bear againſt the Sheat at e in *Fig.* 4. but if this End of the Socket ſhould not be quite ſo oblique as the Sheat, it may be help'd, by taking off a little of the Wood at the Point c.

Fig. 6. Shews the Share, with its right Side upwards, in the ſame Poſture as when it plows; whoſe Side a b ſhould be perfectly ſtreight, but its under Side at c, which is its Neck, ſhould be a little hollow from the Ground, but never more than half an Inch in any Plow, and a Quarter of an Inch in a *Four-Coulter Plow*; ſo that the Share when it is firſt made, ſtanding upon its Bottom, bears upon the level Surface only in three places, *viz.* at the very point a, at the Tail b, and at the Corner of the Fin d.

Fig. 7. Is the Share, turn'd Bottom upwards; and ſhews the Concavity of the Fin at a; which muſt be greateſt in a ſtony rubbly Soil.

Fig. 8. Shews the Share, the right Side upwards, but leaning towards the Left.

In placing of the Share rightly upon the Sheat, conſiſts the well going of a Plow, and is the moſt difficult part of a *Plow-Wright*'s Trade, and is very difficult to be ſhewn. Suppoſing the Axis of the ſtreight Beam, and the left Side of the Share, to be both horizontal, they muſt never be parallel to each other; for if they were, the Tail of the Share bearing againſt the Side of the Trench, as much as the Point, would cauſe the Point to encline to the right Hand, and go out of the Ground into the Furrow; if the Point of the Share ſhould be ſet, ſo that its Side ſhould make an Angle on the right Side of the Axis of the Beam, this Inconvenience would be much greater; and if its Point ſhould encline much to the Left, and make too large an Angle on that Side with the Axis of the Beam, the Plow would run quite to the left Hand; and if the Holder, to prevent its running out of the Ground, turns the upper part of his Plow towards the left Hand, the Fin of the Share will riſe up, and cut the Furrow diagonally, leaving it half unplow'd; beſide, the Plow will riſe up at the Tail, and go all upon the point of the Share: To avoid theſe Inconveniencies, the ſtreight Side of the Share muſt make an Angle on the left Side of the Beam, but ſo very acute, that the Tail of the Share may only preſs leſs againſt the Side of the Trench than the point does. This Angle is ſhewn by the prick'd Lines at the Bottom of *Fig.* 1. where the prick'd Line e f, is ſuppoſed to be the Axis of the Beam let down to the Surface, and the prick'd Line g f parallel to the left Side of the Share; but this Angle will vary as thoſe two prick'd Lines are produc'd forwards to the Fore-End of a *long* and a *ſhort* Beam, keeping the ſame Subtenſe; For *Plow-Wrights* always take this Subtenſe at the Fore-End of a Beam, whether it be a long Beam or a ſhort one; and 'tis the Subtenſe e g, that determines the Inclination the point of the Share muſt have toward the left Hand. *Plow-Wrights* differ much in this Matter; but, by what I can learn by thoſe that make the Plows I ſee perform the beſt, this Subtenſe at the Fore-End of an eight-Foot Beam, ſhould never be more than one Inch and a

Half; and by full Experience I find, that whether the Beam be long or ſhort, the Subtenſe muſt be the ſame; for when my *Plow-Wrights* take this Subtenſe at eight Foot from the Tail, when they make my *Four-Coulter Plow*, whoſe Beam is ten Foot four Inches long, the point of the Share will incline too much to the left, and it will not go well until this Fault be mended, by taking the ſame Subtenſe quite at the End of the Beam; which makes the mention'd Angle more acute.

Fig. 3. Shews the right Hand Side, and upper Side of the *Four-Coulter Plow*, of which V the Iron Ground-Wriſt is ſhewn in *Fig.* 9. long two Foot five Inches, deep at the End b four Inches, and three Eighths of an Inch thick, except at the End a, where it is thin enough to bend, ſo as to ſit cloſe to the Share, as at e, in *Fig.* 6. The Ground-wriſt has four ſmall Holes near its End a, into one of which goes a Nail, to faſten it to the Sheat, thro' the long Hole in the Side of the Socket of the Share, as at a, in *Fig.* 10; and then it will ſtand in the Poſture ſhewn by e f, in *Fig.* 6. From the Outſide of the Ground-Wriſt at f, to the Out-ſide of the Share at b, is eleven Inches and a half, which is the Width of the lower Part of the Plow-Tail at the Ground; the Ground-Wriſt has ſeveral Holes at the upper Side of its broadeſt End, as at b, in *Fig.* 9. by which it is nailed to the lower part of the Drock T, as in *Fig.* 3. which Drock with its Perforations is ſhewn in *Fig.* 11.

Fig. 12. Is the Earth-Board, with its Inſide upwards; the Notch a b ſhews the riſing of the Wood, which takes hold of the Edge of the Sheat, to hold it the firmer, to which it is faſtened by the Hole c and d; and at the other End it is faſtened to the Drock, at the Hole e. All which is ſeen as it ſtands mark'd with W, in *Fig.* 3, But this Pin, with which it is faſtened to the Drock, is bigger in the Middle than at each End; which prevents the Earth-Board from coming near the Drock: By this Pin, the Earth-Board is ſet at a greater or leſs Diſtance from the Drock, as there is Occaſion to throw off the Furrow farther from the Plow at ſome Times than at others: It always ſtands conſiderably farther out on the right Hand than the Ground-Wriſt does, which is one Reaſon that the Drock is made crooked, bending outwards in that Part.

The long Handle X is *Fig.* 13. long five Foot four Inches, broad in the wideſt part four Inches, pinned to the Sheat thro' the Holes a, b, and pinned to the Drock thro' the Hole c.

The ſhort Handle S is *Fig.* 14, and is long three Foot nine Inches, pinned to the hinder Sheat (being *Fig.* 15.) by the Hole a,and to the Top of the Fore-Sheat above the Beam by the Hole b.

The Handles are made ſo long, for the more eaſy guiding of the Plow; but the lazy Plow-Man is apt to cut them off ſhorter, cloſe up to the Plow, to the end that bearing his whole Weight thereon, he may in a manner ride inſtead of walk; but if he ſhould thus ride on long Handles, he would tilt up the Fore-End of the Beam, and raiſe the Share out of the Ground.

The chief, and moſt indiſpenſably neceſſary Thing to be obſerved, is, to place the four Coulters in ſuch a Manner, that the four imaginary Planes deſcribed by the Edges of the four Coulters, as the Plow moves forwards, be all of them parallel to each other, or very nearly ſo; for if any one of them ſhould be much inclin'd to, or recede from either of the other three, they could not enter the Ground together. In order to place them thus, the Coulter-Holes muſt be made thro' the Beam, in the Manner as they are ſhewn in *Fig.* 3. *viz.* the ſecond Coulter-Hole is two Inches and a half more on the

Right than the firſt, the third two and a half more on the right Hand than the ſecond, and the fourth two Inches and a half more on the right Hand than the third, conformable to the four Inciſions, or Cuts they are to make in a Ten-Inch Furrow; and becauſe no ſingle Beam is broad enough to hold the four Coulter-Holes at this Diſtance, we are forced to add the Piece ſhewn in *Fig.* 16. The ſecond Hole is made part in the Beam, and part in this Piece; the third and fourth are made wholly in this Piece, in which a, b, c, are the Ends of the three Screws, which faſten the Piece to the right Side of the Beam, by their Nuts.

The Diſtance of two Inches and a half, by which each of the three added Coulters ſtands more to the right Hand than that immediately behind it, muſt be reckon'd from the Middle of one Hole to the Middle of the other.

The Fore-part of every Hole muſt incline a little towards the Left; ſo that the Backs of the Coulters may not bear againſt the left Side of the Inciſions made by the Edges.

Each Hole being a Mortiſe, is one Inch and a Quarter wide, with its two oppoſite Sides parallel from Top to Bottom; each of theſe Mortiſes, or Holes, are long at Top three Inches and a half, and at Bottom three Inches; the Back-part, or Hinder-End, of each Coulter-Hole is not perpendicular, but oblique, and determines the Obliquity of the ſtanding of the Coulter, which is wedged tight up to it by the Poll-Wedge i, in *Fig.* 1, as all Coulters are.

Fig. 17. Is a Coulter; a b is its Length, being two Foot eight Inches, before it is worn; e d is its Edge, ſixteen Inches long; d c is the Length of its Handle, ſixteen Inches; this is made thus long at firſt, to ſtand above the Plow, that it may be driven down lower, according as the Point wears ſhorter; this Handle is one Inch and ſeven Eighths broad, and ſeven Eighths of an Inch thick, equally thro' its whole Length: its Breadth and Thickneſs might be deſcribed by a rectangled Parallelogram.

In all Plows this firſt Coulter is, or ought to be, plac'd in the Beam in Manner following; *viz.* its Back to bear againſt the Back of the Coulter-Hole, its right Side above to bear againſt the upper Edge of the Coulter-Hole, and its left Side to bear againſt the lower Edge of the Coulter-Hole; ſo that always three Wedges at leaſt will be neceſſary to hold the Coulter; the Pole-Wedge before it, as at i, in *Fig.* 1; another Wedge on the left Side of it above, and a third on the right Side underneath: The Coulter-Hole muſt be ſo made, that the Coulter ſtanding thus acroſs the Hole, its Point may incline ſo much towards the Left, as to be about two Inches and a half farther to the Left than the Point of the Share, if it were driven down as low as it; but it never ought to be ſo low in any Plow: As to its bearing forwards, the Point of the Coulter ſhould never be before the Middle of the Point of the Share: What Angle the Coulter would make with the Bottom of the Share, may be ſeen by the Poſture it ſtands in, in *Fig.* 1. If it ſhould be ſet much more obliquely, it would have a greater Force to raiſe up the Pole-Wedge, and get looſe.

The three added Coulters ſhould ſtand in the ſame poſture with this already deſcribed, in regard to the Inclination of their points towards the Left, and this is a very great Advantage to them; for by this Means, when the Fin is rais'd up, by turning the Handles towards the Left, their points do not riſe out of the Ground on the right Hand, as they would do without this deſcribed Inclination towards the Left; but in regard to their pointing forwards, I find it beſt, that every one of the Three ſhould be a little more perpendicular than that next behind it. So the Coulter 4 ſtands the neareſt to perpendicular of any of them; by this Means, there being more Room betwixt them above than below, they are the more eaſily freed from the Turf, whenever the pieces, being covered with a great Quantity of Couch-Graſs, or the like, riſe up betwixt them, which, tho' this ſeldom happens, makes a Neceſſity for a Man or a Boy to go on the Side with a forked Stick, to puſh out the Turf and Graſs, which might otherwiſe fill the Spaces betwixt the Coulters, and raiſe up the plow out of its Work.

'Tis to be obſerved, that none of theſe Coulters ought to deſcend ſo low as the Bottom of the Share, except when you plow very ſhallow: 'Tis always ſufficient that they cut through the Turf, let the plow go never ſo deep in the Ground.

It is neceſſary alſo, that when you plow very ſhallow, the Fin of the Share be broad enough to cut off the fourth piece or Furrow; elſe that, lying faſt, will be apt to raiſe up the Ground-Wriſt, and throw out the plow: But when you plow deep, the Ground-Wriſt will break off this fourth Furrow, although the Fin be not broad enough to reach it.

Sometimes the firſt, or left Furrow, is apt to come through betwixt the firſt Coulter and the Sheat, and ſo falls on the left-hand Side of the plow: This is no Injury; but yet 'tis prevented, by letting the ſecond Coulter ſtand a little higher than the third, and then the ſecond Furrow holding the firſt at its Bottom, will carry it over, together with itſelf, on the right Side by the Earth-Board; but yet never ſet this, or any of the three added Coulters, ſo high that they may not cut through the Turf. But as for the firſt Coulter, tho' it ſhould cut but an Inch or two within the Ground, the Share will break off the firſt Furrow in raiſing it up.

Remember, as oft as the point of any Coulter is worn too ſhort, that you drive down the Coulter with a large Hammer, carried for that purpoſe; and when it is driven low enough, faſten the Wedges again, ſo as to keep the Coulters in their right poſtures, that their Inciſions may be all of them equidiſtant.

Fig. 18. Is a Nut, with two of its oppoſite Corners turn'd up, by which it is driven round by a Hammer, and has ſo great a Force, that three of them with their Screws properly placed, hold the piece, *Fig.* 16, as faſt to the *Plow-Beam* as if they both were made of one piece of Wood; but as often as the Wood ſhrinks in dry Weather, the Nuts muſt be ſcrew'd farther on, both here and in all other places where they are uſed; particularly, thoſe which hold up the Retch; for if the Sheat ſhould once get looſe, there is no Cure but by a new one.

Betwixt this Nut and the Wood, there ſhould be a thin Iron Bolſter, about the Thickneſs of a Shilling, broader than the Nut, to prevent the Nut from eating into the Wood; eſpecially when 'tis to be often ſcrew'd, as on the Retch of theſe Plows, and moſt of all on the *Hoe-Plow*; but ſometimes we uſe a piece of Shoe-Leather inſtead of an Iron Bolſter.

Note, there muſt be Iron Plates upon all the Coulter-Holes both above and below, three of which are ſeen on the piece in *Fig.* 16. There's no need to ſay how they muſt be nailed on with many Nails made for the purpoſe.

Fig. 19. Is the Iron Collar, faſtned to the Beam by two ſhort Crooks A, B, which take hold of two ſhort Pins driven into the Plow juſt behind the ſecond Coulter-Hole, one on one Side, and the other on the other Side of the Beam. The Crook A is ſeen on the left Side of the Beam near c, in *Fig.* 2. The Crook B doing the ſame on the other Side of

the

the Beam, which is ſeen near a, in *Fig.* 3. C is the Crook (for its Shape called a C) which holds the Tow-Chain to the Collar by the Link D, being part of the ſaid Chain taking hold of its Fore-Claw; the other Claw taking hold of one of the five Notches of the Collar; this Collar is partly ſeen at d, in *Fig.* 2. Both the Claws of the Crook (or C) turn upwards, ſo that they cannot take hold of any thing that may riſe under the Plow: The Uſe of the Notches is to help the Direction of the Point of the Share, which has been deſcribed by the prick'd Lines under *Fig.* 1. As the point of the Share wears, it inclines a little more towards the Right, and is remedied by moving the Crook into a Notch nearer to the Left, which will direct the Point a little more towards the Left; this is more eaſy to be done here than in the common Plow, whoſe Collar moves round the Beam: We can, by changing the Crook from one Notch to another, incline the point of the Share towards the Right or Left at Pleaſure. The Length of each Side of this Collar is a Foot.

The Tow-Chain is beſt ſeen in *Fig.* 3. where the Link Y is that which paſſes through the Box, and is pinned in by the Stake, as has been ſhewn in *Fig.* 1. which Stake is commonly nailed to the Box, to prevent its riſing up. When we would draw up the Plow a little nearer to the Crow-Staves, we take hold of the Crook by a ſecond or third Link. Note, that the ſhortning of the Chain does alſo a little incline the point of the Share towards the Left.

Fig. 20. Is the Iron Wilds; the Leg A is of one piece with that which has the Notch, and that paſſes through the Leg B by the Loop at a; both which Legs paſs through the Box, and are pinned in behind it, by the crooked Pins C, D. This Figure is ſeen with its Crooks on it, both in *Fig.* 1. and *Fig.* 2. Note, that the Holes in the Box thro' which theſe Legs paſs, muſt not be made at right Angles with the Box, but muſt incline upwards, ſo that the Fore-part of the Wilds may be higher than the Hinder-part, or elſe the Upper-part of the Crow-ſtaves would lean quite back when the Plow is drawn. If the Beaſts that draw immediately next to the Plow be very high, their Traces muſt be the longer; elſe they and the Wilds, making too ſmall an Angle with the Tow-Chain at the Box, when they draw hard, the Wheels will riſe from the Ground, and be apt to overturn: This Angle I ſuppoſe ſhould not be leſs than of 160 Degrees, and the Angle made by the Tow-Chain or Traces that are drawn by the Cattle that go before them, will make an Angle with the Tow-Chain at the Box yet much more obtuſe. The Uſe of theſe Notches in the Wilds, is to give the Plow a broader or narrower Furrow: If the Links are moved to the Notches on the right Hand, it brings the Wheels towards the left Hand, which gives a greater Furrow; and when the Links are moved toward the left Hand, it gives a leſs Furrow, by bringing the Wheels towards the right Hand.

The Diſtance betwixt the two Legs of the Wilds is eight Inches and a half; the Length of the Legs is nineteen Inches. They muſt be of convenient Strength; the Links being placed in Notches diſtant from one another, prevent one Wheel from advancing before the other, which would happen if the Links were both in one Notch, or in two adjoining Notches, except they were Middle Notches: Theſe Links are each ſix Inches and a half long.

E is the Ring, by which the two Links, and the two Crooks F and G are held together, and on which they all move.

The Height of the Wheels in *Fig.* 2. The left-hand Wheel is twenty Inches Diameter; the Diameter of the right Wheel is two Foot three Inches; the Diſtance the Wheels are ſet from each other at the Ground, is two Foot five Inches and a half; the Crow-ſtaves are one Foot eleven Inches high, from the Box to the Gallows; they both ſtand perpendicular to the Box, and the Diſtance between the Crow-ſtaves is ten Inches and a half. The Pillow is pinned up at its Ends by two ſmall Iron Pins, which are chained to it, that if they drop, they may not be loſt. Theſe appear in *Fig.* 1. and *Fig.* 2. The Height from the level Surface, up to the Hole in the Box, where the Tow-Chain paſſes through it, is thirteen Inches (being two Inches below the Holes of the Wilds, on the Hinder-ſide of the Box) the Height at the other End, where the Crook of the Collar takes hold of the Pin in the Beam at c, in *Fig.* 2. is twenty Inches high above the ſame level Surface, and ſhews how much the Chain deſcends forward, for drawing down the Plow, and by which Deſcent may be known what Angle the Chain would make with the Surface, if it were produced forwards in a ſtreight Line; which is a Thing material for the good Going of a Plow; and ſo is the Angle the Tow-Chain makes with the Beam; About the Middle of this Tow-Chain, there ſhould be a Swivel, whereby one End of the Chain may turn without the other.

When this *Four-Coulter Plow* is made, I would adviſe that it be tried with only the firſt Coulter, before the other three are put in; for if the Plow does not go well with one Coulter, 'tis not likely it ſhould go well with four; and I never yet have ſeen or heard of any that went well with one Coulter, that did not alſo go well with four, being placed as is here directed.

The Proofs of a Plow's performing well, are theſe; *viz.* If it makes a Furrow of an equal Depth on the right Hand and on the Left, and turns it off fairly: If, in its going, the Tail of the Share, and the Bottom of the Drock, bear againſt the Bottom of the Furrow, and if it goes eaſy in the Hands of the Holder, without preſſing one Arm more than the other, then the Plow is certainly a good one.

The Plowman who is accuſtom'd to a *Two-Wheel'd Plow*, never ſuffers the Wheels to overturn, in turning out at the Land's End, from one Furrow to another; for which purpoſe, after he has lifted the Plow a little round, he has a Knack of holding up the Crow-ſtaves with the End of the Beam, by preſſing his Hand hard againſt the Handle, whilſt the Plow lies down on one Side, until the Horſes, the Wheels, and the Plow come near to a Line in the Beginning of the Furrow; and then he lifts up his Plow, and goes on.

Chap. XXII. *Of the* Drill-Boxes.

The *Drill* is the Engine that plants our Corn and other Seeds in Rows; it makes the Channels, ſows the Seed into them, and covers them at the ſame Time, with great Exactneſs and Expedition.

The principal Parts of the Drill are, the *Seed-Box*, the *Hopper*, and the *Plow*, with its *Harrow*.

Of theſe the *Seed-Box* is the chief; it meaſures (or rather numbers) out the Seed which it receives from the *Hopper*: It is for this Purpoſe as an artificial Hand, which performs the Task of delivering out the Seed, more equally than can be done by a natural Hand.

It is deſcribed, together with ſome of its Appurtenances, in *Plates* 2 and 3.

The MORTISE.

As the *Seed-Box* is the principal part of a *Drill*, ſo is the *Mortiſe* the principal part of the *Seed-Box*.

The following Deſcriptions ſhew how this *Mortiſe* differs from a common Mortiſe.

Fig. 1. *Plate* 2. Shews both the upper and lower Edges of a Turnep *Seed-Box*, and the Manner how they are poſited one over another. a b c d is a rectangled Parallelogram, and ſhews the upper Edges (or Top) of the *Mortiſe*. e f g h being a Figure of the ſame Denomination with the former, is the lower Edges (or Bottom) of the *Mortiſe*. The Line e h is the Length of the lower Edge of the Hinder-End of the *Mortiſe*. a d is the upper Edge of the Hinder-End of the *Mortiſe*, and poſited juſt over the lower Edge of the ſame End. The Space between the Line a b, and the Line e f, ſhews half the Exceſs whereby the Bottom of the *Mortiſe* exceeds the Top in Breadth; as the Space on the oppoſite Side, betwixt the Line c d, and the Line g h, ſhows the other Half of that Exceſs; both which Halves, taken together, ſhew the whole Bevel (or Angle of Inclination) deſcribed in *Fig*. 2. That part of the Line a b, from the Angle at b to the Line f g, which interſects it, ſhews the Exceſs whereby the Top of the *Mortiſe* exceeds the Bottom in Length.

Fig. 2. Is the *Mortiſe* cut down by its four Corners, and laid open. a b c d is a Trapezium with two parallel Sides, and mark'd A, the right Side of the *Mortiſe*; its oppoſite Side e f g h, mark'd B, the left Side of the *Mortiſe*; the Areas of both being true Planes.

d i k h Shew the Fore-End of the *Mortiſe* mark'd C. a l m e ſhew the Hinder-End of the *Mortiſe*, mark'd D. a d h e ſhew the Bottom of the *Mortiſe* already deſcrib'd in *Fig.* 1. If theſe oppoſite Sides and Ends were all raiſed up, until the Angle at b join the Angle at l, and that at m join f, and that at g join k, and that at i join c, the Top of the *Mortiſe* would be formed, and the ſame with the Parallelogram a b c d, in *Fig.* 1. and then the entire *Mortiſe* of the Turnep *Seed-Box* would appear in its true Form, ſtanding upon its Bottom.

This differs from a common Mortiſe, in that it is impoſſible to fit it with a Tenon; becauſe it is narrower above, and ſhorter below, as in *Fig.* 1.

The Areas, or imaginary Planes, of the Top and Bottom of the *Mortiſe*, are parallel to each other, but not equal.

Its two oppoſite Sides are equal, but not parallel, by reaſon of their Inclination to each other upwards, which is the Bevel hereafter to be deſcribed.

The two Ends are neither parallel nor equal, becauſe the Hinder-End D is perpendicular to the Top and Bottom, and the Fore-End oblique, and therefore longer.

When two oppoſite Sides, or Surfaces, are inclined to each other upwards, I call that Inclination a Bevel; but when they are inclined downwards, I call it a Bevel revers'd.

The Line a e, being the Bottom, or Baſe, of the Hinder-End D, by being longer than the Line l m, ſhews that the *Mortiſe* is bevel.

The two prick'd Lines m n and l o, with the Line l m, and part of the Line a e, make a rectangled Parallelogram, which ſhews the exact Depth of the *Mortiſe*, and forms on each Side of it a rectangled Triangle, the one m e n, and the other l o a; which Triangles being ſimilar and equal, and their acute Angles at l and m, being each of four Degrees, make the whole Bevel, or Inclination of the Sides of the *Mortiſe*, to be of eight Degrees, their Hypothenuſes being the ſame with the Sides of the *Mortiſe*.

This End D, being raiſed up to its Place, will be at right Angles with the Plane of the Top and of the Bottom of the *Mortiſe*, which, being both rectangled Parallelograms, prove that Bevel, or Angle of Inclination, to be the ſame from one End to the other of the Sides, which Sides are the Hypothenuſes of thoſe two Triangles: But this could not be proved by the Triangles in the oppoſite End C; becauſe the Baſes being the ſame with the other, and having their Legs longer, the vertical Angles at k and i are more acute. The Legs are longer; becauſe the End C, when in its Place, is not at right Angles with the Top and Bottom of the *Mortiſe*, as the End D is.

The next Thing to be deſcribed in the *Mortiſe*, is the Bore, great Hole, or Perforation; which is beſt ſhewn in the Side of a *Mortiſe* of a *Wheat-Drill*, being larger, as in *Fig.* 3. wherein c e b d is the great Hole, and is a Section of a hollow Cylinder, that paſſes through the *Mortiſe*, with its Axis parallel to the Edges of the Ends of the *Mortiſe*: This Cylinder, being cut by the Side of the *Mortiſe* obliquely, and not parallel to its Baſe, is an Ellipſe.

The prick'd curve Line is a Circle parallel to the Baſe of the Cylinder, and the curve Line b c d e is the Ellipſis; and this Curve is more or leſs elliptical (or oval) in Proportion to the Angle of Inclination, or Bevel, of the Sides of the *Mortiſe*.

Of this Ellipſe the longeſt Diameter (or *Axis tranſverſus*) b c, is at right Angles with the upper and lower Edges of the Sides of the *Mortiſe*.

Its ſhorteſt Diameter (or *Axis rectus*) d e, is the Diameter of the Cylinder, biſſecting the *Axis tranſverſus* at right Angles in the Center a; and is in this Figure one Inch and a half.

This Ellipſe being concentrick with the Circle, the Letter a is the Center of both.

The Semi-Ellipſis c e b is the Part of chief Uſe, and therefore the Edge muſt of Neceſſity be ſmooth and without Flaws, as muſt the Surfaces of the Sides of the *Mortiſe* betwixt the Ellipſe and the Fore-End.

The Tongue of the *Seed-Box* (*Plate* 3. *Fig.* 1.) differs from that in the Sound-Board of an Organ (from which I took the Idea of it) in Shape, in Situation, and in the Manner of its being fix'd to the *Mortiſe*.

The Tongue, in the Organ, is on its Surface a long Square, or rectangled Parallelogram, a little broader and longer than the *Mortiſe* (or Groove) it ſhuts againſt; but this Tongue on its upper Surface, which is here turned downwards, being a Plane, is a Trapezium of the ſame Shape with the Fore-End of the *Mortiſe* juſt now deſcribed, except that the Tongue has a leſs Bevel.

The Situation of that in the Organ is on the Outſide of the *Mortiſe*, which it ſhuts by its Spring behind it, and opens immediately by the Finger of the Organiſt preſſing down the Key to let in the compreſſed Air to its Pipes; but this Tongue is ſituate within the *Mortiſe* of the *Seed-Box*, and placed almoſt in a Manner diagonally; for had it been placed like the other, the Seed getting betwixt it and the Edges of the *Mortiſe*, would not have given way to its ſhutting (as the Air does to the other) but have kept it always open, which would have render'd it uſeleſs for ſowing of Seeds.

The Manner of faſtning the Organ-Tongue to its *Mortiſe*, is by Parchment and Leather glu'd to its Surface, and alſo to the Sound-Board, at its End which is oppoſite to that preſſed open by the Key, and ſhut by the Spring; but this our Tongue is held within the *Mortiſe*, and moves on an Axis, which paſſes thro' its upper and narrower End, which Axis is the Pin A (which muſt be exactly parallel to the Edge of the End of the *Mortiſe*), and alſo thro' the Hole f, in *Fig.* 3. in *Plate* 2, which is ſeen in its Place at A in *Fig.* 3. *Plate* 3. and likewiſe thro' both Sides of the *Mortiſe* near their upper Edges, and as near the Fore-End of the *Mortiſe* as may be, without the Tongue's rubbing againſt the ſaid Fore-End.

The Breadth of the Tongue muſt be conformed to the Breadth and Bevel of the *Mortiſe*, and when 'tis on its Axis, it being raiſed tight up as far as the ſhort prick'd Line l m in *Fig.* 3. *Plate* 2. being one eighth part of the great Hole, and being there, you ſee its upper-Edges touch both Sides of the *Mortiſe* by their whole Length: Then 'tis rightly made; and by this Touching both Sides of the *Mortiſe* tightly and cloſely, when raiſed up to that Degree, it appears, that the two upper Edges of the Sides of the Tongue are inclined to each other in an Angle that is more acute, by about one Third, than is the Angle of Inclination of the Sides of the *Mortiſe*.

Hence, when the Tongue is let down to its Place, there will be on each Side of it an empty Space, betwixt it and the *Mortiſe*, of the Form of a very acute Triangle, whoſe vertical Angle is more or leſs acute, according as the Tongue approaches nearer to, or recedes farther from the Spindle.

This *Fig.* 1. *Plate* 3. is the Braſs Tongue with its Back-ſide upwards. The two outer Lines a b and c d are the Edges of the upper Surface, (tho' turn'd downwards in this Figure) which are inclined to each other, as aforementioned; but the two inner Lines e f and g h are nearer to each other, whereby this under Surface is narrower than the upper: Both muſt be plain Surfaces, but the upper and its two Edges very free from Flaws, and ſmooth or poliſh'd.

The Reaſon why the under-Surface is narrower than the upper, is to preſerve the Bevel of the empty Triangle: For tho' the Bevel of the Sides of the *Mortiſe* would be ſufficient for this, if both Sides of the Tongue were ſure to keep equally diſtant from the Spindle; yet as the Tongue never is ſo tight on it Axis, but that ſometimes one Corner of it may be nearer to the Spindle than the other, in this Caſe, that Side which is neareſt to the Spindle would reverſe that Bevel, ſo as to make the ſmall empty Space that is betwixt the *Mortiſe* and the Tongue, wider above than underneath.

C C Are the two little Knobs that prevent the Spring from ſlipping to either Side, and are at the Diſtance from one another of the Breadth of the Spring.

Fig. 2. Shews one Side, and the Thickneſs of the Tongue the other Side, being the ſame. a b ſhews the poliſh'd Surface (being a true Plane) whereon the Seed runs down to the Spindle. c d the Backſide, which lies turn'd uppermoſt in *Fig.* 1, b e d ſhews one End of the hollow Cylinder of the Tongue, thro' which its Axis paſſes.

The Length of the Tongue muſt be ſuch, as will reach lower than juſt to touch the Bottom of the great Hole as a Tangent; for if it be not longer than that, it might happen that when the *Mortiſe* is empty of Seed, and the Tongue ſet up cloſe, a Wheel might in Turning, or otherwiſe, go a little backwards, and cauſe a Notch of the Spindle to take hold of the End of the Tongue, and tear it out of the *Mortiſe*; therefore let the Tongue reach a little below the Spindle, as the prick'd Line g h, in *Fig*. 3. of *Plate* 2, doth.

As for the Poſture in which the Tongue ought to ſtand in the *Mortiſe*, it is ſhewn by the three prick'd Lines in *Fig*. 3. *Plate* 2. where the prick'd Line g h makes an Angle of forty five Degrees, being the neareſt that it can ſtand to the Spindle; the prick'd Line i h makes a ſomewhat greater Angle, and it is a mean (or middle) Diſtance from the Spindle; and the prick'd Line k h is ſuppoſed to be its greateſt Diſtance, where the Tongue makes its greateſt Angle with the Top and Bottom of the Mortiſe. If the Tongue ſtood ſo obliquely as to make an Angle much leſs than forty five, the Tongue would riſe too much againſt the Bevel of the Mortiſe, and the Spring would have the greater Difficulty in returning it to its place, when driven back by the Force of the Notches.

And beſide, when the Tongue ſtood wide from the Spindle, there might be ſo much Room betwixt it and the Sides of the Mortiſe, that ſome Seeds might fall through there.

The Steel Spring is D, properly placed upon the Back of the Tongue, in *Fig*. 1. *Plate* 3.

At firſt, I made the Spring double, *i. e.* with two Legs, in Imitation of that in the Organ, and faſtned into its Tongue, much after the ſame manner as the Spring of the Organ is into its Tongue or Flap, which prevents the compreſs'd Air from paſſing out of the Sound-Board, except whilſt the Key is thruſt down by the Finger of the Player; but the *Drill-Spring* requiring to be of a vaſtly greater Strength than that, I made it of Steel, of the Breadth of half an Inch, inſtead of Braſs Wire: This performed very well, and ſeveral *Drills* are yet extant, that have only this ſort of Springs; yet I found there was great Difficulty to ſet the Legs at their due Diſtance from each other; for their ſeaſoning would alter them from what they were, whilſt the Steel was ſoft: They alſo took up too much Room in the upper part of the Mortiſe. Then, to remedy theſe Inconveniencies, I made it ſingle, with only one Leg, which by full Experience is found to be much better than the double one; it does not contain a fourth part of the Metal, and is moſt eaſily made, requiring none of that Trouble and Nicety that the double Spring doth. I ſhall therefore give a Deſcription of the ſingle Spring only.

B The End of the Screw, which holds the Spring to the Tongue, thro' a Hole near the upper End of the Spring; D, the Middle, againſt which the End of the Setting-Screw bears.

Its Length is almoſt the whole Length of the Tongue, the End E reaching very near to the lower End of the Tongue, and the End B is as near the upper End of the Tongue, as it can be placed without touching the Cylinder of the Tongue.

The Breadth is uſually about half an Inch; the Thickneſs muſt be in Proportion to its other Dimenſions, and according to the Degree of ſtiffneſs required.

The longer it is, the thicker it muſt be, to have the ſame ſtiffneſs; but the broader it is, the thinner it muſt be of the ſame Length; ſo that 'tis hard to determine its Thickneſs. 'Tis made ſtiffer or ſtronger by being cut ſhorter; 'tis made weaker or leſs ſtiff by filing or grinding it, either thinner or narrower.

The common Thickneſs is about that of a Shilling.

The Degrees of ſtiffneſs are meaſur'd in this manner; *viz.* Fix two Boards together, leaving a Chink betwixt them, in once place of an Inch long; lay the Spring (when ſeaſoned) a-croſs this Chink, with its Middle exactly over it; then put a ſtring over the ſpring, which may paſs with both Ends thro' the Chink, and tie ſo much Weight to the Ends of the ſtring under the Boards, that will pull down the middle of the ſpring, till it touch the Chink, and is ſtreight with both its Ends; this will ſhew the Degree of ſtiffneſs. But note, that the Spring muſt be crooked, and bear only upon its Ends, with the hollow ſide upwards.

If ten or a dozen Pound Weight pull it down to the Board, 'tis a good Degree of ſtiffneſs, for a large Box: We are not confin'd to be very nice or exact in the Degree of ſtiffneſs; for by our Fingers preſſing it, we that are practis'd in it, know well enough, whether a ſpring be of a ſufficient Degree of ſtiffneſs, without weighing it; but for ſuch who are unacquainted with them, 'tis beſt not to truſt to Gueſs but Weights; and to adjuſt the ſtiffneſs to that of a ſpring, that has been known to perform well.

The ſpring muſt bear againſt the Back of the Tongue at each End, and lie hollow in the Middle: But the degree of Hollowneſs of the ſpring is very material; for thereon depends the diſtance of the Tongue's Motion towards the Spindle by Force of the ſpring, and back again quite to the ſetting-Screw, by the ſeed that is preſſed againſt it by Force of the Notches, when they are moved by the Wheels; becauſe the more the ſpring is curved, the farther will it thruſt the Tongue from its Middle, if its ſtrength be ſuperior to the Force that reſiſts it, as it ought to be when a Notch is paſſed and before the next: This Motion of the Tongue is called its Play.

In order to meaſure the Diſtance (or Quantity) of this Motion, we muſt conſider, that the Tongue moving on its Axis above, deſcribes with its lower End the Arch of a Circle, the Chord of which Arch is the Meaſure required.

To meaſure this by the Angle the Tongue makes at its Center, would be no Rule for making Boxes; becauſe ſome Tongues are longer, ſome ſhorter, in proportion to the different Diameters of the Spindles they move againſt; and yet the Play of the ſhorteſt muſt be as much as that of the longeſt, that is, it muſt deſcribe as great an Arch at the place of preſſure (deſcrib'd in *Fig.* 3. *Plate.* 2.) and therefore the ſhorteſt Tongue would make the greateſt Angle.

A ſhort and eaſy way then, for a Mechanick to meaſure, is thus: Screw in the ſetting-ſcrew until the tongue come within a quarter of an Inch of touching the ſpindle, then take out the ſpindle, and from the Center of the Hole draw a Line on the ſide of the Mortiſe, perpendicular to the tongue, and at the tongue's Edge make a Mark with the Compaſſes, or a Pen; then force back the Tongue againſt the ſetting-ſcrew as far as it will go, (that is, until the ſpring touch the whole Back of the Tongue;) produce the ſaid Line to the ſame Edge of the Tongue, or ſet the End of the Rule thereon, and draw another Line, by the Rule, from the Mark to the Edge of the Tongue, when fartheſt back, and there make the ſecond Mark. The Ruler uſed this Way will ſhew both the Perpendicular and the Meaſure.

But yet a quicker Way, is to ſet the Tongue by the ſetting-ſcrew, up to the Edge of the Hole; and when 'tis forc'd back, meaſure from the Tongue to the neareſt part of the Hole, which will ever be a perpendicular Line drawn from the Center of the Hole to the place of preſſure abovementioned, and make another Mark there: Now the Diſtance between theſe two Marks, is the Meaſure (near enough) of the Tongue's Play at the place of preſſure. Tho' this Line drawn on the ſide of the Mortiſe be not exactly perpendicular to the ſurface of the Tongue, but only to its Edge, yet the Difference is next to nothing, and not to be regarded.

If its Meaſure be a Quarter of an Inch, it is what Experience ſhews to be of a good ſize for all Corn and Peaſe; a little leſs is no Harm, but greater is the moſt fatal Error, into which moſt of the Pretenders to the making of this Machine have fallen; they give the Tongue half an Inch, ſometimes three Quarters of an Inch Play. The Miſchief of this Error is yet farther increaſed, if the ſpring be weak, if the Mortiſe have a too great Bevel, or if the Angle made by the Tongue at the upper Edge of the Mortiſe, be too acute.

When the Tongue has too great Play, the ſeed is apt to be turn'd out too faſt, or elſe too ſlow, in ſpight of the Driller. For when the Tongue is ſet at its due Diſtance from the ſpindle, and is thruſt quite back by the ſeed preſs'd againſt it by the turning of the Notches; but the ſpring being unable to return the Tongue to its former place at ſuch a diſtance, at the time of paſſing the Intervals which are betwixt the Notches; then the ſpace between the ſpindle and the Tongue being too open, the ſeed is ſent down too faſt.

To prevent that, they ſet up the Tongue to the ſpindle, and then, as often as the ſpring happens to overcome the Force of the ſeed's Preſſure (as ſometimes it will) 'tis ſent out too ſlowly.

The Inequality of the Running of the ſeed, makes ſuch Boxes uſeleſs, which the Expence of Two-pence (for another Spring, or new ſeaſoning of that) at moſt would rectify, if the Maker underſtood how to mend his own Work. If Time did permit, more ſhould be ſaid on this Point, becauſe I find it is the *Pons Aſini* of a Workman; ſometimes it may be prevented, when the ſpring is too hollow, and gives too much Play. Screw the ſcrew that holds it on the Tongue, down cloſer, ſo that the lower part of the ſcrew's Head preſs againſt the ſpring, and thereby force its Middle nearer to the Tongue, until you find its Play leſſen'd to its juſt Diſtance.

The ſpring remaining in this compreſſed ſtate, has loſt the weakeſt, and retains only the ſtrongeſt part of its elaſtick Force. Therefore if you find it then too ſtiff, make it weaker by Filing or Grinding, or elſe put another into its place, which is worth honeſtly no more than Two-pence.

This Holding-ſcrew has a pretty broad Head, and is ſcrew'd in by a Notch, like the Screw-pin of a Gun-Lock.

The Hole in the ſpring muſt be ſomewhat bigger than the Holding-ſcrew, becauſe the ſpring muſt have Room to move and play thereon.

If the Middle of the ſpring were againſt the Middle of that part of the Tongue, that is betwixt its Axis and the place of preſſure, the Diſtance of the ſpring's Hollowneſs would be juſt half the Diſtance of the ſpring's Play, to wit, the one eighth part of an Inch; but as the ſpring does not quite reach up to the Axis, and reaches much below the place of Preſſure, the Hollowneſs at the place where the ſetting-ſcrew bears againſt the Middle of the Spring at D, is conſiderably nearer to the place of Preſſure than to the Axis of the Tongue; this Hollowneſs of the ſpring at the ſetting-ſcrew may be ſomething more than the one eighth part of an Inch, to give the ſpring a Quarter of an Inch Play; but it ſeldom has ſo much.

Fig. 4 in *Plate* 2. Shews the Length and Thickneſs of the ſteel ſpring of a Turnep Seed Box; this ſerves both for a Tongue and Spring; it is made firſt ſtreight, and then the narroweſt end of it is turned round, till it reach to a, and forms the Cylinder A, through which its Axis paſſes; but is not welded or joined to the other part of the ſpring at a; it is placed in the Box with the Cylinder part underneath; the Face of this ſpring is ſeen upon its Axis, mark'd K, in *Fig.* 5. its Axis is to paſs thro' the Hole E, and ſcrew into the Hole F, in *Fig.* 2. as is ſeen more plainly at a in *Fig.* 9.

As the Top of every Tongue ought to be even with the upper Edges of the Mortiſe, the Thickneſs of the Cylinder of the braſs Tongue cauſes the Hole in the ſides of the Mortiſe, into which it is held by its Axis, to be far enough from the Edges of the Mortiſe, to be bored and ſcrew'd without Danger of breaking the ſaid Edges; but the ſpring of the Turnep-Drill being ſo very thin, there is ſome Difficulty in making the Hole, ſo high and near the Edges; to prevent which Danger, *Fig.* 7. ſhews the End of a ſmall hollow Cylinder of Iron or Braſs, of the Thickneſs of the Mortiſe, which being put into the Cylinder A, in *Fig.* 4. raiſes the ſpring higher above the Hole; ſo that it may be made as low in a Turnep Mortiſe, as that is which holds the braſs Tongue in the Wheat Drill: But we do not always uſe this inner Cylinder; but muſt then take the more Care in boring the Hole, or elſe it will burſt out at the Edges of the Mortiſe.

Its ſhape muſt conform to that of the braſs Tongue already deſcribed.

The Degree of its ſtiffneſs is known by weighing, as has been directed for the other ſpring; and being

ing laid with its Face downwards over a Chink, with a ſmall piece of Wood of the Thickneſs of a Barley Corn at each End, and a ſtring taking hold of its Middle, and deſcending through the Chink, the Weight of five Pound tied to the End of the ſtring, will juſt bend the ſpring, till it touch the Edges of the Chink; and this is the ſtiffneſs of a ſpring that has performed well, for many Years in drilling of Turnep-ſeed.

The SETTING-SCREW.

Fig. 6. Is the Iron *Setting-Screw*, which paſſes thro' the Hole in the Fore-End of the Mortiſe, *Fig.* 2. and paſſes up to the Middle of the ſpring by the prick'd Line p q in the ſame Figure. The Uſe of this *Setting-Screw* is, to increaſe or diminiſh the Proportion of ſeed to be turned out by the Notches; and this it does by forcing up the Spring and Tongue (where there is one) nearer to, or farther from the ſpindle, whereby the ſeed-paſſage is made wider or narrower, as is ſhewn by the three prick'd Lines in *Fig.* 2. and *Fig.* 3.

Obſerve, that the prick'd Line p q, *Fig.* 2. (being the Mortiſe of the Turnep-Box) ſtands higher than the ſame Line doth in *Fig.* 3. which is the Mortiſe of the Wheat Box. The Reaſon of this Difference is, becauſe the ſpring in the Wheat Box bears at its lower End againſt the Tongue below the ſeed-paſſage, and at its upper end below the Axis of the Tongue, whereby the Middle of that ſpring is lower than the ſpring of the Turnep Box, which being both Spring and Tongue, bears againſt its Axis above, and againſt the ſeed-paſſage below; therefore its Middle is higher. This *Setting-Screw* ſhould be placed perpendicular to the Tongue when at its mean or middle Diſtance from the ſpindle, which may be ſuppoſed to be the middlemoſt of the three mention'd prick'd Lines. This *Setting-Screw* ought to be ſmooth and round at its end which bears againſt the ſpring; for if it ſhould have ſharp Corners or Edges, the ſpring might be wounded by them, and in Time might break there, being preſs'd by every Notch that turns againſt it; and, as I have computed it, a ſpring undergoes one hundred thouſand of theſe Preſſures in one Day's Work, and yet, in my whole Practice, I have had only one ſpring broke, and that was in drilling a large ſort of Peaſe with a Wheat Drill, and was occaſioned by a jagged End of the *Setting-Screw*, which was not placed perpendicular to the ſpring, by which means the rough end of the ſcrew made ſcratches againſt it a Quarter of an Inch long, and ſo deep that the ſpring broke off there: Let not this *Setting Screw* be any longer than juſt to force the Tongue up to the ſpindle; for if it ſhould be longer, an ignorant Driller might happen, by the Force of the ſcrew, to break the Tongue, or its Axis; but in the Turnep Drill, which has only a Spring inſtead of a Tongue, the *Setting Screw* may be a Thread or two longer; becauſe the ſpring will yield a little to it, after it touches the ſpindle, and is ſometimes of Uſe in that Reſpect, when the Notches are too large. This ſcrew muſt be of ſuch a Bigneſs, that it may not be in danger of bending; for if it ſhould be bent, it could not be ſcrewed up with any Certainty, becauſe its end being crooked would be below its place at one half Turn, and above it at the other half Turn; and ſo the ſpring might be ſet farther from the ſpindle inſtead of nearer, and nearer inſtead of farther, by the Crookedneſs of the *Setting Screw*. Its Head may be made with a Notch in it, to be ſcrew'd in with a Knife, or elſe with a Head like a T, to be turned with the Fingers, which I think is beſt, eſpecially for a Wheat Drill; becauſe as the Brine and Lime which ſtick on the Wheat grow drier, it will run faſter; and therefore the *Setting Screw* muſt be frequently ſcrew'd in to leſſen the Seed Paſſage.

The Seed Paſſage, or place of Preſſure, is where the ſeed paſſes down betwixt the Spindle and the Tongue; and is in that part where they are neareſt together, for there the Seed is preſſed hardeſt by the Force of the Notches which carry it down: And this Paſſage is higher or lower, as the Tongue ſtands nearer or farther from the ſpindle; for as it ſtands wider, it becomes nearer to perpendicular to the Top of the Mortiſe, and then the *Seed Paſſage* is higher; and when it ſtands neareſt to the ſpindle, then the *Seed Paſſage* is loweſt. This appears in *Fig.* 3. by the three prick'd Lines *a n*, *a o*, and *a p*.

The Spindle, with its Notches, is beſt ſhewn where it is large, and made of Wood, as that of the Wheat *Seed Box*; 'tis a ſolid Cylinder that paſſes thro', and fills the great Hole, or hollow Cylinder of the Seed Box; 'tis of various Lengths, according to the Diſtance its Wheels go aſunder; it is always in large Boxes the Axis of two Wheels, and turns round with them, as the Axis of the one Wheel of a Wheel Barrow doth with that. Theſe Wheels by their Circumferences meaſure out the Ground over which they carry the Seed Box, and by the Notches in their Axis, deliver down the ſeed equally, whether they move ſwift or ſlow; becauſe an equal Number of Notchfuls of ſeed will be delivered thro' the *Seed Paſſage* at each Revolution of the Wheels.

The Notches reſemble thoſe in the Hinder Cylinder of a Cyder Mill; which break the Apples by turning againſt the Notches of the Fore Cylinder, as our Notches turn againſt the Tongue, bruiſe the Apples which come betwixt them. As our Notches might ſometimes bruiſe ſoft ſeeds, if the Tongue ſtood cloſe to the Notches, without any ſpring behind it to give Way to their Preſſure, and return the Tongue again to its place, at every Interval betwixt Notch and Notch.

The beſt Way, that I can think of, to ſhew the making of theſe Notches, is by a ſection of the ſpindle at right Angles, in the Middle of the Notches, as in *Fig*. 4. of *Plate* 3. which is a Circle whoſe Circumference is cut off by ſix Notches; which ſhew the different ſorts of Notches, that increaſe or diminiſh the Proportion of Seed to be carried through the *Seed Paſſage* by them: The Length of the Notches we never alter; but make them always parallel to the Axis of the Spindle, and of the Length of the Diſtance there is between the lower Ends of the oppoſite *Axes tranſverſi* of the Ellipſes, or great Holes of the Mortiſe; for if any part of the Surface of the Spindle ſhould be betwixt the End of a Notch and the Hole, one or more ſeeds coming betwixt that ſurface and the Tongue, might hold it open, and prevent its preſſing againſt the Notch, to hold the ſeed therein from falling without the Turning of the Wheels.

This Proportion of Seed is alter'd by the Number of Notches, and by their Depth, or Breadth, or by both. *b c* is the Depth of a Notch, which we call its Side, and is that which takes hold of the ſeed, and carries it down thro' the *Seed Paſſage*. The Manner of cutting this is ſeen by its being a Portion of the Radius A *c*. The Bottom of a Notch is made in different Forms: As, firſt, it may be convex; as is ſhewn by the curve Line *b d*. We may enlarge the Capacity of this Notch, by taking off the Convexity of its Bottom; as in the Bottom of the Notch ſhewn by the Line *e f*; and if we would increaſe it more, we make it concave; as g *h*.

But of whatever ſort, or Dimenſions one Notch is made, all the reſt ſhould be the ſame exactly; and conſequently the Interſtices (or Intervals) of which the Line *f c*, being an Arch of the Circle, is the Breadth of, one of the Interſtices (or Intervals) between Notch and Notch muſt be equal, and cannot be otherwiſe, if the Notches are all equal, and equidiſtant, as they appear in the adjoining *Fig.* 5. which is a ſection like the former, and ſhews ſix Intervals, with their ſix Notches, of the ſize wherewith we drill *St. Foin* with high Wheels; but when we would drill very thin, 'tis better to have but four or five Notches inſtead of ſix.

Fig. 6. Shews a Notch of the ſpindle. *a b* is the upper Edge of the ſide of the Notch, being always an acute ſolid Angle. *c d* is the Edge of its Bottom, being always an obtuſe Angle. *e f* is the Angle made by the ſide and bottom, and is always ſhorter than the aforeſaid two Edges, by reaſon of the Obliquity of the two Ends; this Angle is never obtuſe, except when the Bottom of the Notch is concave. Theſe three Lines muſt be parallel to the Axis of the Spindle.

Fig. 7. Is one End of the afore deſcribed Notch; the Line *a b* being joined to the Line *f d* of *Fig.* 6. and the Line *a c* being join'd to the Line *b f* in *Fig.* 6. would be the End of that Notch in its proper Poſture; and then the Line *b c* being an Arch of the cylindrical Spindle, would be the Edge of the upper End of the Notch. *a b c* being the Area of this End, is a Plane, and, when in its place, makes an Angle of forty five Degrees with the Axis of the Spindle. The other End is the ſame with this in all reſpects, except that it being oppoſite to it, it is inclined to it in an Angle of ninety Degrees, at the bottom Angle of the Notch, at the Line *e f* in *Fig.* 6.

Fig. 8. Is a Notch lying with its Ends near it, and is of the ſame Dimenſions with thoſe appearing in the *Seed Box*, *Fig.* 3.

The *Cover* B appears with its upper Surface rightly placed in the Mortiſe, in *Fig.* 3. of *Plate* 3. where its Breadth is ſhewn to be the ſame with that of the Mortiſe; but its Shape and other Dimenſions, are beſt ſeen in *Fig.* 3. of *Plate* 2. where *ſ t* is its Length, and reaches from the hinder End of the Mortiſe, to within the Tenth of an Inch of the upper End of the *Axis tranſverſus* of the Ellipſis; its greateſt Depth is from *v* to *w*, and is made ſo deep, that its Bottom, at *w*, bearing againſt the End of the Mortiſe, may prevent its Point, which is at *t*, from ſinking down to touch the Spindle, which it neither muſt do, nor be ſo high above it as to ſuffer a Seed to paſs between the Spindle and it; tho' the Seed is not apt to paſs that Way, becauſe the Notches throw it forwards from the *Cover*. *z* is the Hole, thro' which an Iron Screw-Pin paſſes, and ſcrews into the oppoſite ſides of the Mortiſe, to hold it firm in its place: 'Tis made ſo thin betwixt *x* and *y*, both for Lightneſs, and that the Seed may come the more freely to the Notches, without Danger of Arching at that End. The Uſe of the *Cover* is to prevent any Seed from falling down behind the Spindle.

Fig. 10. *Plate* 2. Is the Fore End of a Wheat Mortiſe, with its Hole A, thro' which the *Setting Screw* is ſcrewed, and paſſes up to the Back of the Tongue by the Line *p r* in *Fig.* 3.

Fig. 9. in *Plate* 3. Is the Hinder End of a Wheat Mortiſe, which by its prick'd Lines, and the two right angled Triangles they make, ſhews the Bevel of the Mortiſe, and alſo its Depth; it alſo ſhews the Difference of the Bevel of the Mortiſe, and that of the Tongue, *Fig.* 1. which is placed againſt it: Theſe Figures, having been already demonſtrated in the Deſcription of the Turnep Mortiſe, and in theſe I need ſay no more of it, but that I think theſe laſt mention'd Figures, ſufficient Directions for underſtanding, and making the Mortiſe of a Wheat Drill.

Fig. 3. of *Plate* 3. Exhibits to View a Wheat *Seed Box*, with its Appurtenances, ſtanding upon its Bottom; B the braſs Cover; C the Tongue hanging upon its Axis; *c* the end of the Iron ſcrew that holds on the Spring, coming thro' the Tongue, and filed ſmooth with it; *a a a* are three Notches of the Spindle, with their bevel ends; *b b* are two Interſtices betwixt the Notches.

Hitherto we have been ſpeaking of the Parts *contained* in the Wheat *Seed Box*; let us now come to the Parts *containing*: As, firſt, *d e f g* is the upper Surface of the braſs *Seed Box*, ſhewing the Top of the Mortiſe, and what it contains; *hhh* & *hhh* ſhew the Ends of the hollow Cylinder, and its Baſes coming out on each ſide, farther than the Box; for if it did not project farther out than the ſides of the Box, the ſurface of it would be ſo narrow, that it would cut the wooden Spindle by the Friction made between it and the Spindle; but the ſurface being of this Breadth, never wears into the Spindle, but makes it ſmooth and ſhining; *i i i*, and *i i i* ſhew a Portion of the wooden Spindle (of at Inch and a half Diameter) coming out of the hollow Cylinder, on each ſide of the braſs Box.

The Spindle is kept from moving end-ways, by Wreaths, in the ſame Manner as the Axis of a Wheel-Barrow is; which Wreaths ſhall be deſcribed together with the *Hopper*. *k* Is the Hole by which the Fore End of the *Seed Box* is held up to the Bottom of the *Hopper*, by a Screw and Nut. *l* Is the Hole where the Hinder End of the Box is held up, in the ſame Manner as the Fore End is.

m n o p ſhew where the two Halves of the *Seed Box* are join'd together.

Fig. 10. Shews the Outſide of one Half of the braſs *Seed Box*. A A A ſhew the Thickneſs of the projecting Baſe of the hollow Cylinder, which is made the thicker, to the end that the Hole may be bored larger, and made an Inch and three Quarters Diameter, when a Spindle that is to go therein is required to be of that Bigneſs, by reaſon of its extraordinary Length, as it is in the *Fore Hopper* of the Wheat Drill. B C ſhews the Thickneſs of the Ends of the *Seed Box*, whereby it is held up to the Bottom of the *Hopper*; if they are not quite a quarter of an Inch thick, they will be ſtrong enough; eſpecially C, which is the hindermoſt, and which is never pull'd down by the turning of the Spindle, but is rather raiſed up by it.

D Is the Head of the Counter-ſcrew, to be turn'd by the Fingers, to preſs againſt the ſide of the *Setting Screw*, to keep it from turning of itſelf, when it is worn looſe.

E is the Hole for the Axis of the Tongue. F is the Hole of an Iron Screw Pin, which both holds the Cover to its Place, and alſo the two Halves of the Box together. G is the Hole for another Screw Pin, which holds the two ſides of the Box together. H and I are Holes for two other Screw Pins, which likewiſe hold the two Halves of the Box together, and are placed one above, and the other below the *Setting Screw*; for otherwiſe that Screw, and its Counter-ſcrew, might force open the Joining of the Box, and then the *Setting Screw* might be looſe, and the Bevel of the Box might be altered; but theſe Screws being one on each ſide of it, prevents this Inconvenience.

Fig. 8. in *Plate* 2. Is one half of a braſs Turnep *Seed Box*, lying with its Inſide uppermoſt, which ſhews the left ſide of the Mortiſe, and half the Fore End, and half the Hinder End of the Mortiſe, and half of each Screw Pin Hole, by which it is held up to the Bottom of the *Hopper*. A is half the Hole of the *Setting Screw*, ſhewing in the Middle of it the End of the Counter-ſcrew. B is half the Hole, by which the ſteel ſpring Cover is held in with a ſcrew; all the other Holes are for the ſame Purpoſes, as have been ſhewn in the Wheat *Seed Box*.

Fig. 9. Is the whole Turnep *Seed Box*, ſtanding upon its Bottom: Part of its ſteel ſpring Tongue appears in its Place, as alſo ſome of the Notches of the Spindle; but more eſpecially the Cover A, which differs from the Cover of the Wheat Mortiſe, this being a very thin ſpring, whoſe lower end juſt reaches to touch (but not bear upon) the Spindle at the upper end of the tranſverſe *Axes* of the Ellipſes. The Mortiſe being filed away at the end, in order that the upper end of this Spring, and the Screw which holds it, may not lie above the upper ſurface of the Box. This ſpring is made very weak, to the end that if by any Chance a ſoft ſeed ſhould ſtick in a Notch, and be turn'd round, this ſpring might ſuffer it to paſs by without breaking it. B C are the two Flaunches or Sides, made neceſſarily of this Breadth, for bearing againſt the Wood of the Bottom of the *Hopper*, to prevent the Seed from falling out betwixt the Wood and the Braſs, and that the Hole in the *Hopper* may be broader than this narrow Mortiſe of the *Seed Box*. The left Flaunch B, being next the wide ſide of the *Hopper*, lies all open, except on the Outſide of the prick'd Lines, where it is covered by the Wood of the end of the *Hopper*, when it is ſcrew'd on to its Place; but the Flaunch C, on the right ſide, will be all covered by the end of the Box, that will ſtand upon it, and will reach ſo the prick'd Line that touches the edge of the

Mortiſe. D is the End of the *Setting Screw*, appearing in its Place with a Notch, whereby it is to be turned by a Knife; but I think it better to have an End like a T, to be turned with the Fingers. E is one End of the hollow Cylinder, which projects beyond the Flaunch, that there may be more Room for the Crank to turn (without ſtriking againſt the end of the *Hopper*, or againſt the Flaunch) on the Outſide of the Box or *Hopper*, and for that the longer the Cylinder is, the better the braſs Spindle will turn in it.

Fig. 11. Is the Spring Cover, with its Hole, whereby it is ſcrew'd into its Place, as it is ſeen mark'd A, in *Fig.* 9.

Fig. 12. Is the *Setting Screw* pointing againſt its Hole, its Head being flat, that it may be turned by the Finger and Thumb.

Fig. 13. Is the *Counter-Screw*, to be turned in the ſame Manner.

Fig. 5. Shews the braſs Spindle of the Turnep Seed Box, and the Manner of turning it againſt its ſteel Tongue, or Spring; which Manner is different from that of Turning the larger Spindles for Boxes of a larger ſize, ſuch as the Wheat Seed Box.

This Spindle, being but half an Inch Diameter, is too ſmall to be turned by the two Wheels, as the larger Spindles are; not only becauſe it would be in Danger of breaking by the Weight of the *Hopper*, and by the Twiſting (or Renching) of the Wheels; but alſo becauſe it would ſoon become looſe, by wearing the hollow Cylinder thro' which it paſſes; and it would be apt to open the braſs Flaunches from the Bottom of the *Hopper*, whereby the Seed might run out, beſide ſeveral other Inconveniencies, all which are prevented by turning the Spindle in the Manner ſhewn in this Figure; for here the Spindle never preſſes againſt the hollow Cylinder, with any greater Force than that of its own Weight, which is ſo very little, that the Friction made by it is next to nothing.

A The Spindle, exactly fitting the Bore of the hollow Cylinder; which when it enters the ſaid Cylinder at its left end, in *Fig.* 9. will be ſtopp'd by the Wreath B B B; which Wreath being circular is caſt on the Spindle, and is Part of it; the other end of the Spindle will then appear without the Right-hand End of the ſaid hollow Cylinder, at E in *Fig.* 9. and is kept there by the Wreath *Fig.* 14. which is to be put on upon the end of the Spindle, until it come to the Shoulder at a, which Shoulder is exactly even with the end of the hollow Cylinder; ſo that this Wreath will touch the end of the ſaid Cylinder by its whole Surface. Then, to fix in this Wreath from coming off, we make uſe of the Slider *Fig.* 15. whoſe two Claws A, B, being thruſt down by the two Notches of the Spindle, at *b* and *c*, until its other Part C, which is perpendicular to its Claws, comes down to the Flat of the Spindle, and invirons one half of the Hole, covering the Part of the Flat which appears of a darker Colour; and then the upper Part of C, in *Fig.* 15. makes one level Surface with the Flat D of the Spindle; and then the Iron Fork E, being ſcrew'd into the Hole F, holds down the Slider faſt, ſo that it cannot riſe up; and then the Spindle, being in its Place, will run round without moving end-ways, being confin'd by theſe Wreaths.

The Spindle being thus placed, ſo that it may turn eaſily, we place the Seed Box upon its Flaunches with its Bottom upwards; and then ſetting one ſharp Point of a Pair of Compaſſes, or ſome ſuch Inſtrument, upon the Spindle, within the Mortiſe, cloſe to the Edge of the Hole or Ellipſe at the end of the tranſverſe Ax, turn round the Spindle until the ſaid Point makes a Mark round the Spindle, which will be a Circle; by the ſame Means make ſuch another Mark at the oppoſite Ax; then unſcrew the Fork, and take out the Slider, pull off the Wreath, and take out the Spindle, and cut the Notches between the two ſaid Circles and Marks; the Edges of the ends of the Notches muſt be Arches of theſe Circles. Theſe Notches ſhould differ from thoſe already deſcribed in the Wheat Drill, in nothing but the Smallneſs of their Dimenſions; their Depth ſhould be about the Thickneſs of a Turnep-Seed, or ſomething deeper. The Breadth of their Bottoms is uncertain, and muſt be greater or leſs according to their greater or leſs Number; but we commonly have ſeven or eight Notches, and make them about the Breadth in which they appear in this Figure; but whatever their Number be, they muſt be all equal, and ſo muſt all their Interſtices.

G Is the end of a wooden Spindle, thro' which paſſes the iron Crank H, and is faſtned to it by its Screw and Nut, at *d*; Part of which Crank enters the Wood at *e*, which prevents its turning in the Spindle.

This Crank, by its other End, paſſing thro' the two Legs of the Fork E, and equally diſtant from the Top and Bottom of it, turns the Spindle by the Motion of the Wheel which is fix'd on the other end of the wooden Spindle. If this Crank were to turn the Spindle by a ſingle Pin, inſtead of this Fork, the ſeed could never be delivered out equally to the Ground; for as ſoon as the Pin began to deſcend, and decline from being perpendicular to the Horizon, it would by its own Weight falling down, turn the Spindle half round in a Moment, and there remain with its other end downwards perpendicular to the Horizon under the Spindle, until the Crank reach'd it there, and ſo no Seed would be turn'd out by one Semi-Circle of the Wheel, and a double proportion would be turn'd out to the Land that was meaſur'd by the other Semi-Circle; but the hinder Leg of the Fork, bearing againſt the hinder Part of the Crank, prevents this Inconvenience.

The Line *f g* is Part of the Surface of a Board, thro' which the wooden Spindle paſſes, and by which it is held in its Place; as ſhall be ſhewn hereafter.

The Axis of this wooden Spindle ought to fall into a Line with the Axis of the braſs Spindle; but, unleſs Care be taken to prevent it, the wooden Spindle will ſo much wear the Hole thro' which it paſſes, and be worn by it as to have Room in the Hole to deviate from this Exactneſs, and may deſcend ſo low, that the Crank may come out of the ends of the Fork; and for this Reaſon it is, that the Fork is made ſo long as it is; but when this wooden Spindle does, by the Contrivances hereafter ſhewn, keep its Axis in a Line with the Axis of the braſs Spindle, or very nearly ſo, then the Legs of the Fork need be no longer than half an Inch; and in that Caſe, the Joint of the Crank which is perpendicular to the Spindle, muſt be ſhorter, or elſe deſcend deeper into the Wood, ſo that its end which turns the Fork, may be in the Middle betwixt its Bottom and the end of its Legs.

The Uſe of the other end of the Spindle is this; when we have a Mind that it ſhould be turned by the left Wheel inſtead of the right, we ſcrew in the Fork into the Hole I, and place a ſhort Screw in the room of the Fork, to hold down the Slider.

Note, It is not abſolutely neceſſary, that the hollow Cylinder, which appears on the ſides of the Seed Box, ſhould both, or either of them, project farther than the Flaunches; but I think it better that it ſhould do ſo (at leaſt) on that ſide which is next to the Fork.

This Cylinder ſhould be bored as true, and as even as the Barrel of a Fuſil is bored; and the Edges and Surfaces of its ends muſt be ſmooth, and without Jaggs, to the end that the Wreaths may turn glibly againſt them.

The Figure or Shape of all ſorts of Seeds diſpoſes them, more or leſs, to form an Arch, when they are preſſed from above, and confined on all ſides.

The moſt effectual Way to prevent this, is to take Care, whenever many Seeds are to deſcend together by their own Gravity thro' a narrow Paſſage, that ſuch Paſſage be never narrower downwards than upwards; but, on the contrary, that it be wider downwards, on ſome or one of its ſides; in which Caſe, if the Surfaces of all the ſides of this Paſſage be ſmooth, 'tis impoſſible that Seed ſhould of themſelves form an Arch therein.

On this Maxim depends the infallible Performance of a *Drill*, and from hence are derived the Uſes of the Bevel of the Mortiſe: What I mean by the Word *Bevel*, in general, has been already defin'd.

The Bevel of the Mortiſe of the Seed Box, is that Inclination of its ſides, whereby it is wider downwards, and narrower upwards, by which Means the Seed is prevented from arching in the Mortiſe before it deſcends to the Notches of the Spindle. And this is the firſt Uſe of our Bevel; for this arching might happen in the Mortiſe, if the Planes of its ſides were parallel to each other, and would be unavoidable, if their Inclination were downwards, as it is upwards; but theſe Planes opening downwards, the lower the Seed deſcends, the more Room it has to expand; ſo that the very Weight, which would otherwiſe cauſe it to arch and ſtop, does by Means of this Bevel force it to deſcend to the Notches, and then 'tis ſafe from all Manner of Danger of ſtopping. The Ends of the Mortiſe are at ſuch a great Diſtance from each other, and the Cover ſo very thin as to lie almoſt even with the upper Part of the Spindle, that the Seed can never form an Arch that Way, or if it did, the continual Motion of the Tongue would immediately break it down at the Fore-end of the Mortiſe.

The ſecond Uſe of this Bevel is, that it gives Room for the Tongue to be in the ſame manner bevel, tho' in a leſs Degree: By this Means, the Seed cannot by any Impediment be ſtopp'd in its oblique Deſcent to the Notches, from the Fore-end, and all that other Length of the Mortiſe, along, and upon the Surface of the Tongue.

But if the Mortiſe had not this Bevel, the Tongue could not have it; for then, either the Upper-ſurface of the Tongue muſt have no Bevel at all, which would deſtroy the two empty Triangles which ought to be on its ſides, or elſe it muſt have a Bevel the contrary Way (*i. e.* a Bevel revers'd) and be narrower downwards than upwards, which would cauſe the Seed to arch thereon, and hinder its free Deſcent to the Notches.

A third great Uſe of this Bevel is, that beſides the Bevel of the Tongue aforemention'd, it gives Place for two empty Triangles, one on each ſide the Tongue, which have each its vertical Angle extremely acute at the Axis of the Tongue, and have their Baſes at the Bottom of the Mortiſe and of the Tongue: Theſe Triangles are alſo Bevels, which conſiſt of the Difference (or Complement) of the Bevel of the Tongue and that of the Mortiſe. The latter being about one Third greater than the former, *i. e.* one Third of the whole Bevel of the Mortiſe is divided between theſe two Triangles, to each a ſixth Part; ſo that if the Angle of Inclination of the ſides of the Mortiſe were nine Degrees, then the vertical Angle of each of theſe empty Triangles would be of one Degree and thirty Minutes, and ſix Degrees would be left for the Bevel of the Tongue. And theſe triangular Spaces help to ſecure the free Motion of the Tongue, and free Deſcent of the Seed down its Surface; becauſe they permit no Impediment to lodge in them, they being, by means of the Bevel of the Mortiſe, wider downwards, both obliquely and perpendicularly, ſo that no Duſt, nor whatever elſe happens to get in betwixt the Tongue and the ſide of the Mortiſe, can reſt there; for it will be immediately removed thence by the Motion of the Tongue, and its own Gravity, and either thrown perpendicularly down, or elſe obliquely to the Notches, and the firſt Notch that takes it will carry it out at the Seed Paſſage.

The fourth Uſe of the Bevel is, that thereby the Sections of the hollow Cylinder (before deſcribed) do form Ellipſes inſtead of Circles; which they muſt have been, if cut parallel to the Baſes of that Cylinder, and the Sections muſt have been thus parallel, had the Mortiſe been without any Bevel.

Now the two Semi-Ellipſes, which are on the Fore-ſides of their longeſt Axes or Diameters, and next to the Tongue, are oppoſite to, and do ſtill uniformly depart from each other, even from the Upper-end of their ſaid longeſt Axis, until they arrive at the Lower-end of the ſame Axis, which is below the Seed Paſſage, as its Upper-end is very near the Cover.

This Opening of theſe oppoſite Semi-Ellipſes, makes it impoſſible for any Thing of itſelf, to get into the remaining Parts of this hollow Cylinder, betwixt them and the ſolid Cylinder, call'd the Spindle, which turns continually therein, when the Wheels are going; for you will ſee, that if you make a Mark on the Spindle, cloſe to the ſide of the Mortiſe, at the Upper-end of the longeſt Ax of the Ellipſe; and then turn the Spindle until this Mark come againſt the Lower-end of the ſame Ax, and there make another Mark on the Spindle, cloſe to the ſide of the Mortiſe, and draw a Line from one Mark to the other, parallel to the Ax of the Spindle, which will be the Meaſure of that Part of the Bevel of the Diameter of the Hole; every Point in this Line will, by an entire Revolution of the Spindle, generate a Circle, which will cut the Ellipſe in two Places, once on the Fore-ſide of its longeſt Axis, and once on the Back-ſide or hinder Half of it; and that all theſe Points, in this Surface of the Spindle, deſcrib'd by theſe Circles, will enter the Hole, by the ſaid hinder Semi-Ellipſe, as the Spindle there turns upwards (as it always does) and they will all again come out on the fore Semi-Ellipſe, as they deſcend towards the Lower-end of the ſaid Ax of the Ellipſe.

As theſe Points thus come out of the Hole, or (if I may uſe the Expreſſion) as they emerge, they oppoſe every Thing that would enter the Hole, they ſtill moving from the Hole, and puſh away from it whatever they meet; nay, if any thing were in the Hole, theſe Points (whereof this Surface conſiſts) would bring it out by this Semi-Ellipſis, which is always preſs'd by the Seed when the Drill is at work; but as theſe Points immerge by the other Semi-Ellipſis which is behind the Spindle, they can carry with them into the Hole nothing but Air, becauſe the Cover never ſuffers any Thing elſe to come there from above; and the Seed falls out of the Notches by its own Gravity, juſt before it reaches the Lower-end of the tranſverſe Ax, being the Place where the oppoſite Ellipſes are fartheſt aſunder; and none of it is ever carried ſo far back as the hinder

Semi-Ellipſes; and therefore nothing can be carried into the Hole from below.

Thus, that Part of the ſurface of the Spindle will keep the Hole empty and clear, before ever any Notches are cut; but when the Notches are made on the Spindle, they have yet a much greater Force to drive and expel whatever would enter the Hole, their Shape being ſuch as nothing can enter againſt their bevel Ends; but what is at their Ends will be thrown preſently into the *Mortiſe:* Inſomuch that when a Spindle has been too little for the Hole by a Quarter of an Inch, that is, a ſixth Part of the Diameter of the Hole, it will perform very well in drilling large ſpecies of Seeds, and when the Mortiſe is run empty, nothing at all is found in the Hole, it being thus kept void and clean by the Notches.

Note, That what is here, and elſewhere, ſaid of the Ellipſe of the one Side of the Mortiſe, muſt be underſtood the ſame of its oppoſite Ellipſe, on the oppoſite ſide of the Mortiſe.

All theſe Advantages accruing from this Bevel of the Mortiſe, I believe that without it, all Attempts of making a Machine to perform the Work which this does, would have been vain.

There is alſo within the Mortiſe unavoidably another Bevel, which is as the Reverſe of the former, and notwithſtanding is as uſeful; and this Bevel is the Inclination which Part of the curvilineal Surface of the Spindle, beginning a little above the Fore-end of the ſhorteſt Diameter of the Ellipſes, and deſcending down to the Seed Paſſage, has to the lower Part of the Surface of the Tongue oppoſite againſt it. Theſe two Surfaces meeting one another below, when the Tongue is ſet up cloſe to the Spindle, form a mix'd Angle, which ſtops up the Seed Paſſage, except when a Notch comes againſt it.

When the Tongue is ſet from the Spindle, to the Diſtance of ſeveral Diameters of one of the Seeds that are to be drill'd, this revers'd Bevel cauſes the Seed to arch at the Seed Paſſage, and ſtop there, till the Notches force it thro', which would, without this Arching, fall out by its own Gravity, without the turning of the Wheels.

The Seed arches here the more firmly, the more 'tis preſs'd upon by the incumbent Seed from above it; and the former Bevel (which I call the Bevel of the Mortiſe) permits the incumbent Weight to preſs the harder on the Seed that is near the Seed Paſſage; and this might be reckon'd a fifth Uſe of the former Bevel: for as it prevents the Seed from arching in any other Part of the Mortiſe, ſo it does, by the ſame Means, cauſe it to arch the more ſtrongly at the Seed Paſſage, which is ſometimes (*viz.* when the Tongue muſt be ſet wide) as neceſſary, as 'tis for it to eſcape arching before it comes thither. And the more ſtrongly this Arch preſſes againſt the Tongue, the more the Tongue by its ſpring preſſes againſt it; and this Preſſure being reciprocal and equal, the ſeed cannot fall out ſpontaneouſly; for when the Paſſage is thus wide, if you throw into the Mortiſe a few ſeeds, ſuppoſe five or ſix at a Time only, they will all paſs through immediately, without any Motion of the Wheels; but if you throw in a large Quantity together, there will only a few of the lowermoſt fall through, unleſs the Wheels do turn and throw them down by the Force of the Notches.

Indeed we do not care to ſet the Tongue ſo very wide from the ſpindle, unleſs it be when we are oblig'd to plant a very much larger Proportion of ſeed than the Notches are deſigned for, and when we have no Opportunity of changing the Wheels for ſuch as are lower, nor of changing the Spindle for another that has greater or more Notches in it.

Four and twenty Gallons of large Peaſe, is as proper a Proportion to drill on an Acre, as ſix Gallons of Wheat is.

There are divers Ways to vary (*i. e.* increaſe or diminiſh) the Proportion of Seed; as, firſt, by the Setting-ſcrew, with which we can, without any Inconveniency, ſet the Tongue ſo far from the ſpindle, as to permit one Round of the Notches to turn out four Times the Quantity, as it will do when the Tongue is ſet cloſe up to the Spindle; and thus we can vary the Proportion by innumerable intermediate Degrees.

Next, if we would increaſe the Proportion yet farther, we can enlarge the Notches; but we cannot add to their Number, unleſs there be Room to double it, by making a new Notch between every two; but we cannot diminiſh the Proportion of ſeed by the ſame Notches, becauſe they cannot be made leſſer or fewer.

If we would make any other Alteration in the Proportion of Seed by the Notches, it muſt be done by making another ſet of them; which we may do, becauſe the wooden ſpindle may have three Rows of Notches in it, of which we may uſe either, by moving the Wreaths and Wheels towards one End or the other of the wooden ſpindle; as ſhall be ſhewn in the Deſcriptions of the *Hoppers*.

But as for the braſs ſpindle of the Turnep-Drill, we can have but one ſet of Notches in it, and therefore, tho' we can increaſe the Proportion of Seed by inlarging the Notches, or perhaps by doubling their Number, yet we cannot leſſen the Proportion of Seed by the Notches, unleſs we have a new ſet of them, and that will occaſion a Neceſſity of having another Spindle; but as to the Setting-ſcrew of the

Turnep Drill, it will increaſe the Proportion of Seed with the ſame Notches, much more than the Setting-ſcrew of the Wheat Drill will do.

The other Way of varying the Proportion of ſeed in the ſame Boxes, is by the Diameter of the Wheels when we can alter them; for Wheels, of what Diameter ſoever they are, muſt turn round all the Notches at one Revolution; ſo that Wheels of twenty Inches Diameter will deliver out a third Part more ſeed than Wheels of thirty Inches Diameter, into the ſame Length of the Channels; but we ſeldom have any Occaſion to alter the Wheels, unleſs it be on Account of planting a ſpecies of Seed of a different Magnitude, as the largeſt ſort of Peaſe, and ſmall-grain'd Wheat, or *St. Foin* Seed are.

Theſe are all the Ways we have to alter the Proportion of ſeed we drill with the ſame Seed Boxes: Theſe two ſizes, already deſcribed, being ſufficient for all ſorts of Corn and Seeds which we commonly ſow, from Marrow Peaſe to Turnep-ſeed; but for drilling of Beans, the Boxes muſt be larger, and are commonly made of Wood, the ſpindle two Inches Diameter, or more, and the Boxes two Inches wide: Where note, that this increaſing of the Width of the Mortiſe, from an Inch and a half to two Inches, increaſes the Quantity of ſeed to almoſt double; becauſe this Half-Inch is all added to the Middle of the Notches, where they are deeper than their Ends, the Bevel of which takes up a conſiderable Part of the Length of the Notches. For Beans, they alſo contrive to have their Wheels as low as conveniently they can: Theſe wooden Drills are now become common in many Places.

The wooden and braſs Seed Boxes differ not in any of the moſt eſſential Parts of them; only the wooden Box muſt be thicker, as the Wood is not ſo ſtrong as Braſs; the Spring is made ſtreight inſtead of crooked, and being let into the Back of the wooden Tongue, bears againſt it at each End; and the Channel into which it is placed, being made hollow in the Middle, the Spring has its Play there, and muſt be ſtiffer, and have a little more Play in the Bean-Drill, than in any leſſer Seed Box.

I, at firſt, made all my Seed Boxes of dry *Box-Tree* Wood, which perform'd very well, and are ſtill uſed: But a few Years ago, a Gentleman adviſed me to make them in Braſs; the doing of which has put me to a great deal of Trouble and Expence, for want of underſtanding the Founder's Art; yet this I do not repent; becauſe they are, in ſome reſpect, better than thoſe made in Wood; eſpecially to thoſe who do not well underſtand their Fabrick; for to ſuch, the ſwelling and ſhrinking of the Wood was inconvenient in ſmall Boxes: And I now am told that they are caſt in *London* of the beſt Braſs, at the Price of one Shilling *per* Pound, and ſo ſmooth as to require very little Filing. And theſe braſs Boxes being alſo more laſting than Wood, and not much more expenſive, when Workmen know how to make them, I think it not worth while to give any particular Directions for making them in Wood.

As to the Spindles of the Turnep Boxes, I have often made them with a mix'd Metal, of half Pewter and half Spelter, which perform very well, and are eaſily made; becauſe this Metal will melt almoſt as ſoon as Lead, in a Fire-ſhovel, to be caſt in a Mould; but Braſs will not melt without a Crucible.

The firſt Idea that I form'd of this Machine, was thus; I imagin'd the Mortiſe, or Groove, brought from the Sound-Board of an Organ, together with the Tongue and Spring, all of them much alter'd; the Mortiſe having a Hole therein, and put on upon one of the Iron Gudgeons of the Wheel-Barrow, which Gudgeon being enlarg'd to an Inch and a half

Diameter, having on it the Notches of the Cylinder of a Cyder-Mill, on that Part of it which ſhould be within the Mortiſe, and this Mortiſe made in the Ear of the Weel-Barrow (thro' which the Gudgeon uſually paſſes) made broad enough for the Pupoſe; this I hoped, for any thing I ſaw to the contrary, might perform this Work of Drilling, and herein I was not deceived.

As for placing a Box over this Mortiſe to carry a ſufficient Quantity of Seed, it was a Thing ſo obvious, that it occaſion'd very little Thought; and an Inſtrument for making the Channels, not much more; neither for applying two Wheels, one at each end of the Axis, inſtead of the ſingle Wheel in the Middle of the Axis of the Wheel-Barrow.

At firſt my Plow made open Channels, and was very rude, being compoſed of four rough Pieces of Planks, of little Value, held together by three ſhoots, or Pieces of Wood, which held them at a Foot Diſtance one from the other; theſe Pieces being cut ſharp at Bottom, made the Channels tolerably well in fine Ground. But I ſoon contrived a Plow with four Iron Shares, to make Channels in any Ground; this drew a *Hopper* after it, having four Seed-Boxes at its Bottom, carried on a Spindle by two low Wheels, which had Liberty to riſe and ſink by the Clods that they paſs'd over; the Seed Boxes delivered their ſeed immediately into the open Channels.

This *Plow* and *Hopper* were drawn by a Horſe, and the ſeed lying open in the Channels, was covered ſometimes by a very light *Harrow*, and ſometimes by a Hurdle ſtuck with Buſhes underneath it.

I ſoon improv'd this Plow to perform better, and to make ſix Channels at once, and ſometimes a great many more.

This Plow and Hopper, with their Improvements and Alterations, are ſhewn in *Plates* 4 and 5.

Chap. XXIII. *Of the* Wheat-Drill.

F*IG.* 1. in *Plate* 4. is the *Drill-Plow*, which makes the Channels for a treble Row of Wheat, at ſeven Inch Partitions, and covers the Seed by the Harrow which moves on its Beams. A is the Plank, three Foot and a half long, eight Inches and a half broad, one Inch and a quarter thick; its upper and under Surfaces are true Planes. B, B the two Beams, each two Foot four Inches long, two Inches three Quarters broad, and two Inches and a Quarter deep, ſtanding under the Plank at right Angles with it, and held up to it by the four Screws and Nuts a, a, a, a, the one being at the ſame Diſtance from the right, as the other is from the left end of the Plank.

This Plow makes its Channels by three Sheats, and their Shares and Trunks; the firſt, or foremoſt, of which Sheats, ſtands under the Middle of the Plank, with Part of it appearing at b; and is fully deſcrib'd in *Fig.* 2. where A is the Tenon of a convenient ſize, two Inches broad between Shoulder and Shoulder, three Quarters of an Inch thick; it is driven into the Plank thro' a Mortiſe, and pinn'd up by its Hole; it ſtands thus obliquely, and pointing forwards, that it may ſtand the more out of the Way of the Funnel: The Shoulder at *a* is a quarter of an Inch. The hinder Shoulder from the Tenon to the Angle at *b*, is three quarters of an Inch. The Depth of the Back of the Sheat, and Thickneſs of the Share, when 'tis on, from *b* to *c*, is nine Inches and a Quarter; and the Angle at c muſt be a right Angle, contrary to the Opinion of ſome, who fancy it ought to be acute, ſuppoſing that when this Angle is right, whilſt the Seed is deſcending by the Back of the Sheat, the Plow as it moves forwards, would get before the Seed, and ſo it might fall to the Ground behind the Trunk; but this Miſtake is for want of conſidering the vaſt Diſproportion between the Celerity of the Seed's deſcending near the Earth, and the ſlow Progreſs of the Plow; the Seed deſcending at the Rate of ſixteen Foot in a Second of Time, and the Plow proceeding but about three Miles an Hour, does not advance the Thickneſs of a ſeed whilſt it is falling to the Ground by the whole Depth of the Sheat.

The Thickneſs of the Sheat is an Inch at its upper Part.

Fig. 3. Is the Share lying Bottom upwards. *a* Is its Point. *b* The Socket, three Inches long, ſeven Sixteenths of an Inch broad. *c* Is the Hole by which it is faſtned up to the Sheat. *d* Is another Hole which is never made Uſe of, except when the Share being faſten'd up by the other Hole, inclines to either ſide; then we draw it right by a Nail driven into this Hole. *e*, *e* Are two very ſmall Notches, into which the ſides of the Trunk are jointed, to protect them from being torn out by the Earth or Stones that might rub againſt them. *f* Is the Tail of the Share, which when it is in its Place will make the right Angle before deſcribed in *Fig.* 2. and from which Tail to the Fore-part of the Socket, is the Length of the Bottom of the Sheat, *viz.* ſix Inches and a half. The Breadth of the Share three quarters of an Inch.

Fig. 4. Shews one ſide of the Share. The prickt Line *a e* ſhews the Bevel of the Fore-end of the ſocket,

ket, the Upper-Edge of which muſt bear upon the Fore-part of the ſheat below *f* in *Fig.* 2. and the other Part of the ſhare will bear againſt the Bottom of the ſheat, from *d* to *c*, and will be faſtned up by a flat Nail, paſſing thro' the foremoſt Hole of the ſhare, and entring the Hole *g* in the ſheat; which Nail being bended in the ſaid Hole (which Hole ſhould be at leaſt an Inch Diameter) will hold the ſhare faſt to the ſheat, and by unbending this Nail, the ſhare may be eaſily taken off upon Occaſion, without damaging the ſheat. *Note*, This Hole in the ſhare ought to be wider below than above, and the Head of the Nail of the ſame ſhape, or elſe as the ſhare wears thinner, it might come off. The prick'd Line near the Fore-part of the ſheat, ſhews where a ſhoulder muſt be cut on each ſide of it, becauſe otherwiſe the ſheat being thicker than the Breadth of the ſocket of the ſhare, could not enter it: But take Care that the ſhare do not bear againſt theſe ſhoulders.

Fig. 5. Is one ſide of the Trunk, being a thin Plate of Iron, and is often made of the Blade of an old ſcythe; 'tis to be riveted on to one ſide of the ſheat, to another of the ſame on the oppoſite ſide, by three Rivets paſſing thro' them both, with the ſheat in the middle of them; which Holes appear both in the plate and in the ſheat. Theſe thus riveted on do form the Trunk at the Back of the ſheat. The whole Breadth of this Plate is an Inch and three Quarters; but three Eighths of an Inch being riveted on to the ſheat, there remains but an Inch and three Eighths for the Trunk. The Length of the Plate is the ſame with the Depth of the ſheat, and ſhare, except that it ſhould not reach to the Bottom of the ſhare, by about the Thickneſs of a Barley-Corn, to the end that it may not bear againſt the Ground, as the ſhare doth. The Notch at the Bottom of the Plate, is that which anſwers the Notch in the Tail of the ſhare: The Corner of the Plate at *a*, we make a little roundiſh, that it may not wear againſt the Ground.

This Plate thus riveted on the ſheat, and another of the ſame on the other ſide oppoſite to it, compoſe the Trunk, which is *Fig*. 6. *a d* Is the Edge *a b* of the Plate *Fig*. 5. *b c* Is the like Edge of the oppoſite ſide of the Trunk. A Is the Back of the ſheat, which together with the Tail of the ſhare when in its Place, makes the Fore-part or Length of the Trunk; the Thickneſs of this Back of the ſheat is the Width of the Trunk, and from this Back of the ſheat to the ſaid Edges of the Plates, may be call'd the Depth of the Trunk. The Upper-ends of theſe two Plates *a* and *b* we ſpread open a Quarter of an Inch wider, for half an Inch down, than the reſt of the Trunk, for the more free Reception of the ſeed from the Hole of the Funnel; we likewiſe take Care that the two lower hinder Corners of the Trunk do not incline to one another, to make the Trunk narrower than the Back of the ſheat, leſt the Earth ſhould be held in by them, and fill the Bottom of the Trunk.

Fig. 7. Is one of the hinder ſheats, and appears in part at *c* in *Fig*. 1. It is faſtned into one of the Beams by its Tenon, which being driven into a Mortiſe, is pinn'd in by a Pin paſſing through the Beam, and the Tenon cut off even with the upper ſurface of the Beam: This Tenon ſtands more oblique than that of the Fore-ſheat, that there may be the more Wood between its Mortiſe and the Funnel, its hinder-ſhoulder being ſhort; its fore-ſhoulder at *a* muſt be very ſhort, not above the Eighth of an Inch; but its ſhoulder *b* three Quarters of an Inch. The Tenon is alſo ſhoulder'd on each ſide, as well as before and behind. The Thickneſs of this ſheat ſhould be greater than that of the fore-ſheat; becauſe it is much narrower. The Depth of this ſheat is leſs than the fore-ſheat, by the Depth of the Beam; it is in all other reſpects the ſame with the fore-ſheat, except that it and its ſhare are ſhorter. The ſocket of this ſhare is but an Inch and one Eighth long, its Breadth half an Inch, and from the Fore-Part of the Bottom of the ſocket to the End of its Tail, but three Inches. Its Point from the ſocket at Bottom is but three Quarters of an Inch, whereas the Point of the Fore-ſhare is an Inch and three Quarters: There is but one Hole whereby the Share is faſtned up to the Sheat. Its Trunk is no wider than the other; for we cut a Rabbet on each ſide of the ſheat, that the Plates, which are the ſides of the Trunk, may come within three Quarters of an Inch of one another. Its Tenon being narrower than the Tenon of the Fore-ſheat, muſt be thicker than it.

The other Hinder-ſheat, and all its Accoutrements, muſt be the ſame as this of *Fig.* 7.

The Workman muſt take Care that the Tenons of the ſheats be not made croſs the Grain of the Wood; and therefore muſt make them of crooked Timber.

Fig. 8. Shews how the Share is made of four Pieces; of which *a* is a Piece of ſteel for the Point, its larger End being cut bevel for the ſhape of the Fore-end of the ſocket. *b* Is a Piece of Iron for the other End of the ſhare, from the Socket to the Tail; the other two Pieces *c* and *d* are the iron ſides, which being welded on to the other two Pieces, and cut off to the Length, form the Share with its Socket, more exact than it can be made out of one Piece of Iron.

Now we return to the firſt Figure; where the Fore-ſheat being fix'd up at equal Diſtance from each End of the Plank, and as near to the Hinder-edges of it as can be, allowing Room for the Funnel C to ſtand with the Fore-ſide of its Hole, to make one ſurface with the Back of the Sheat, and for the hinder Part of the Trunk not to reach the Edge of the Plank, there muſt be alſo room for the fore ſtandard D to ſtand perpendicular to the Plank, acroſs the Tenon of the Sheat.

This Standard being cloſe to the Fore-ſide of the Fore-Hopper, there muſt be ſo much Room between it and the Hole of the Funnel, that the ſeed may drop from the Seed Box into the Middle of this Hole. Thus much for placing the Fore-ſheat.

Next for the two Hinder-ſheats; they muſt be placed at equal Diſtance from the ſides of the Beams, and ſo near to the hinder Ends of the Beams, that there may be Room to make the Funnels in them, and their Tenons to come up between their reſpective Funnels E and F, and their reſpective Standards G and H, which Standards muſt be ſet perpendicular to the Beams.

The Diſtance of theſe Sheats from the Plank muſt be ſuch, that the Wheels of the hinder Hopper may not ſtrike againſt the Plank, nor againſt the Spindle of the fore Hopper; and the Semi-Diameters of theſe Wheels being eleven Inches, there ought to be a Foot between the Center of each Wheel and the Plank; but we ſometimes cut Notches in the Plank, to prevent the Circles of the Wheels from coming too near the Plank.

For the nearer the Hinder-ſheats ſtand to the Plank, the better; but theſe Beams may be placed nearer to, or farther from the Plank, by their Screws and Nuts, at Pleaſure.

Theſe Beams muſt be ſet at ſuch a Diſtance from one another, that the Shares may be fifteen Inches aſunder from the Inſide of one to the Outſide of the other.

To try whether all theſe Sheats and Shares are truly placed, ſet the Plow upon a level ſurface; and then, if they be right, the Fore-ſhare will touch ſurface by its Point and Tail, and likewiſe the Hinder-ſheats will do the ſame; except that ſome Workmen will have it, that the Plow goes better, when the Tails of the Hinder-ſheats are a Barley-Corn's Thickneſs higher than their Points, and then their Tails will want ſo much of touching the ſurface.

The Shares muſt be all of them parallel to the Beams, and conſequently to one another.

The Channel made by the Fore-ſhare and ſheat for the middle Row, being at equal Diſtance between the two Hinder-ſheats, is covered by them, they raiſing the Mould over the Seed from each ſide of this Channel.

The *Harrow* I is drawn by the Beams, to which it is faſtned to their Inſides at *d* and *e*, having each a ſmall iron Pin, paſſing thro' each End of the Legs of the Harrow, and thro' the Beams; each having a Nut on the Outſides of the Beams, and being ſquare in the Beams, that they may not turn therein to looſen their Nuts; but are round near their Heads, that the Harrow may eaſily move thereon.

The round Ends of the Legs of the Harrow are put thro' its Head I, at the round Holes *f* and *g*; and pinned in behind it, to the end that either Tine of the Harrow may deſcend at the ſame Time that the other riſes, where the Ground is uneven.

The two wooden Tines K and L are pinned in above the Head, and have each of them a ſhoulder underneath. They ſtand ſloping; ſo that if they take hold of any Clods, they do not drive them before them, but riſe over them. They are of a convenient Length, to give Room for the Harrow to ſink and riſe, without raiſing up the Shares; and to give them the more Room to move: The Legs of the Harrow are crook'd downwards in the Middle.

The Diſtance of theſe Tines from each other is twenty two Inches; ſo that each Tine going three Inches and a half on the Outſide of each Channel that is next it, fills it up with Earth upon the Seed, from the Outſides of it; which cauſes the Rows to come up ſomething nearer the inner ſides of the Channels, than to the outer ſides, from whence the Earth is brought into them by the Tines; and the two outer Rows by this Means come up at fourteen Inches aſunder, tho' the Channels were fifteen Inches aſunder.

This Way of Covering adds more Mould to the Top of a Ridge; whereas if the Channels were covered by Tines, going within or between them, the Mould would be thrown down from the Top of the Ridge: And theſe Tines ſtand with their Edges and Points inclining outwards, by which Means they bring in the more Earth to the Channels.

If we find that the Harrow is too light, we tie a ſtone upon it to make it heavier, and ſometimes we fix a ſmall Box of Board on the Middle of it, to hold Clods of Earth for that Purpoſe.

The fore Funnel C has its upper Edges two Inches high above the Surface of the Plank. It is five Inches ſquare at Top; its four oppoſite ſides being Planes equally inclined to each other downwards, until they end at the Hole in the Bottom of the Funnel, which Hole is continued quite thro' the Plank into the Trunk. The ſhape of this Hole is ſhewn in *Fig.* 9. where the four Lines *a b*, *b c*, *c d*, and *d a*, each Line being three Quarters of an Inch, make a true Square, and are the upper Edges of the Hole. The three prick'd Lines *e f*, *f g*, and *gh*, being each of them longer than the former, tho' as little as poſſible, make the three lower Edges of the Hole; which being thus wider below than above, and having all its ſides true Planes and ſmooth, 'tis impoſſible for the Seed to arch therein. The Fore-ſide of this Hole is perpendicular to the upper and lower Surfaces of the Plank, and, together with the Back of the Sheat, makes one plane Surface.

When we drill a large ſpecies of Seed, as Peaſe or Oats, we can make this Hole a full Inch ſquare at Top, and of the ſame ſhape wider at Bottom; which tho' it be wider than the Trunk, except at its Top, the Seed will not arch there, becauſe there is Room behind, the plates being broader than the ſides of the Hole; for there can be no arching in the Trunk, unleſs the Seed were confin'd behind as well as on each ſide.

The Holes of all our Funnels ought to be of the ſame ſhape with this deſcribed; tho', as I am inform'd, the Pretenders to the making of this Plow, make the Holes of their Funnels the reverſe of this; which being wrong-way upwards, the Seed is apt to arch in them, except the Holes are very large.

Of this Plow, *Fig.* 1. the two hinder Funnels E and F differ from the fore Funnel (which has been deſcribed) *firſt*, in Dimenſions; theſe not being ſo deep, becauſe they being made in the very Beams, their upper Edges are in the upper ſurface of the Beams, and their Holes at the Bottom, being about the Eighth of an Inch deep. The Depth of the Funnels muſt want the Eighth of an Inch of the Thickneſs of the Beams; but we make each Funnel an Inch and a Quarter broader at Top than its Beam, by adding a Piece of Wood to each ſide of its Beam, which reaches down about half-way its Thickneſs; and theſe Pieces being firmly fix'd on by Nails, to the ſides of each Beam, the Legs of the Harrow take hold of theſe Pieces, which are in the Inſide of theſe Beams. When the Plow is taken up to be turn'd, the Man who turns it, takes hold of the Head of the Harrow with one Hand, and lays the other upon the Hopper, or Spindle, to keep it level, and to prevent either of the fore Wheels from ſtriking againſt the Ground, whilſt the Plow is turning round.

Another Difference there is between the ſhape of theſe hinder Funnels from that of the former, to wit, that each Fore-ſide of the hinder Trunks muſt not be quite ſo oblique as the reſt; becauſe then the upper Edge of theſe Fore-ſides might be too near the Tenons of the Sheats, and there might not be ſufficient Wood betwixt them, to prevent the Sheats from being torn out; a Thing which has never happen'd, that I know of. We ſometimes make theſe hinder Funnels of a roundiſh ſhape, like a Cone inverted; except that the Part which is next the Sheat, is not ſo oblique as the reſt, for the Reaſon already given.

The only Advantage propoſed by this roundiſh ſhape is, that there is leſs Wood taken out than from the ſquare Corners, and therefore more Wood for the added Pieces to be faſtned to the Beams, than in the ſquare Funnels.

M and N are two Pieces of Wood, each eleven Inches long, two Inches broad, and two Inches thick: Theſe are ſcrew'd on near each End of the Plank, by two Screws and Nuts each; they ſtand parallel to the other Beams, and have each a double Standard, or Fork O and P in them, perpendicular to the Plank, by which Standards the fore Hopper is drawn, and guided, in the Manner as is ſeen in *Fig.* 21.

Theſe Standards ought to be braced (or ſpurr'd) before and behind, and on their Outſides; they never being preſs'd inwards, have no Occaſion of Braces there: Theſe are to be ſo placed, that when the Spindle is in their Forks, it may be exactly over the Hole of the Funnel, ſo that the Seed may drop into the Middle of it, when the Plow ſtands upon an horizontal Surface, the Spindle being alſo exactly parallel to the fore Edge of the Plank.

Fig. 10. Is D in the Plow *Fig.* 1. It is two Foot long, two Inches broad in its narroweſt Part, and half an Inch thick in the thinneſt Part, and two Inches at its Shoulders above the Plank. It is pinn'd through the Plank before the Funnel, having one of its Legs on each ſide the Tenon of the Sheat; it ſtands perpendicular to the Plank; its only Uſe is to hold the fore Hopper from turning upon the Spindle, being put thro' a Thing (*Fig.* 22.) like the Carrier of a Latch, nail'd on to the upper Part of the Fore-ſide of the Fore-Hopper, in which Thing this Standard has Room to play, or move ſide-ways, to the end that either Wheel may freely riſe up.

Fig. 11. Is one of the Hinder-ſtandards, which being placed in the Beam, as G or H, perpendicular to it, is driven into a Mortiſe, and pinn'd into the Beam. It has a Shoulder behind, and another before, and a third on its Outſide; which Shoulders ſerve inſtead of Braces, to keep it from moving backwards, forwards, or outwards; it is two Foot four Inches long, two Inches broad, and an Inch thick; it is placed with its broad, or flat ſides, towards the ſides of the Beams. It is made ſo thin, becauſe it ſhould have the more Room for the Hopper to play on it, and therefore muſt have its ſtrength in its Breadth. The Part at *a* muſt ſtand foremoſt.

The Standards G and H are both alike, except as they are oppoſite: Their Uſe is to draw, guide and hold up the hinder Hopper; they are to be placed perpendicular to the Beams, and at equal Diſtance from each ſide of thoſe Beams, and at ſuch a Diſtance before the Funnels, that when the Fore-ſide of the Hopper by its whole Length bears againſt the Hinder-ſurface of the Standards, the Seed may drop into the Middle of both Funnels, the Plow ſtanding upon an horizontal ſurface.

Be ſure to take Care, that the Sheats, Funnels, and Standards be ſo placed, that the Spindle of the Hopper may be at right Angles with the Beams.

Q and R are Part of the Limbers, which are alſo called Shafts, Sharps, and Thills; from whence the Horſe that goes in them is call'd a Thiller. Theſe Limbers are ſcrew'd down to the Plank, by two Screws and Nuts each. The Limbers are kept at their due Diſtance by the Bar S; near each End of which Bar, there is a Staple with a Crook underneath each Limber, to which is hitch'd or faſtened a Link of each Trace, for drawing the Plow. This Bar is parallel to the Plank, and ſeven Inches and a half before its Fore-edge.

The Limbers muſt be mounted higher or lower at their Fore-ends, according to the Heighth of the Horſe that draws in them; and this may be done by the ſcrews that hold them to the Plank, and by cutting away the Wood at the two Hinder-ſcrews, or at the two foremoſt ſcrews, or by Wedges.

Every Workman knows how to *team* the Limbers; that is, to place them ſo on the Plank, that the Path of the Horſe which goes in the Middle betwixt them, may be parallel to all the Shares, and ſo, that a Line drawn in the Middle of this Path, might fall into a ſtreight Line with the Fore-ſhare, ſtanding on the ſame even ſurface with the Path; for otherwiſe the Plow will not follow directly after the Horſe, but will incline to one ſide.

The Uſe of the Trunks of this Plow is for making the Channels narrow, of whatſoever Depth they are; but without Trunks, the Channels muſt be made wide by ground Wriſts, which ſpread the ſides of the Channels wide aſunder, to the end that they may lie open for receiving of the ſeed; and the deeper they are, the wider they muſt be: By this Width of a Channel, the ſeed in it is more difficultly cover'd, and the Channel fill'd with the largeſt Clods, and the ſeed comes up of a great Breadth, perhaps three or four Inches wide, ſo that the Weeds coming therein are hard to be gotten out.

To avoid theſe Inconveniencies of wide Channels, I contrived Trunks like thoſe deſcribed, except that they were but five or ſix Inches high; and the tops of their Plates bending outwards from each other, form'd two ſides of a Funnel; and the Wood between the two Plates being cut bevel at the Top, was as the Fore-ſide of a Funnel to this Trunk; it was open behind from Top to Bottom, the Wheels were low, and the Seed Boxes narrow: The ſeed in theſe Channels was eaſily cover'd, eſpecially thoſe ſorts which were ſown in dry Weather; for then the fineſt Mould would run in and cover the ſeed, as ſoon as the Trunks were paſt it.

The ſeed in ſuch a narrow Channel comes up in a Line, where the Row not being above a Quarter of an Inch broad, ſcarce any Weeds come in it; and when the Weather is dry, the Earth of the Channel not lying open to be dry'd, the ſeed comes up the ſooner.

I had two Reaſons for making of theſe Trunks higher, as they are now us'd: The one was to avoid the too great Length of the Shares; and my other Reaſon was, that with thoſe low Trunks, and long Shares, there could not be two Ranks of ſhares, and their Hoppers in the Plow, which are neceſſary for making very narrow Partitions, and abſolutely neceſſary for planting this treble Row of Wheat; for if three ſhares for making the ſeven Inch Partitions were placed in one Rank, the Mould (which is always moiſt or wet, when we plant Wheat) would be driven before the ſhares, there not being Room for it to paſs betwixt them.

Fig. 12. Is one End of the hinder Hopper laid open. I call it one End (altho' it be an intire Box by itſelf) becauſe this Hopper is ſuppoſed to have its middle Part cut out, to have a clearer ſight of the Plow and fore Hopper; as is ſeen in *Fig.* 15. which is the whole Hopper in two Parts. In this *Fig.* 12. A is the Inſide of one End of the Hopper, made with ſeveral Pieces of half Inch Elm-Board nail'd on to the Poſt *c a*, on the Fore-ſide; which Poſt is a little more than half an Inch ſquare, and ſeventeen Inches and three Quarters long, being the Depth of that Part of the Hopper which holds the ſeed. B is the Fore-ſide of this Hopper; which muſt be nail'd on to the ſaid Poſt, being of the ſame Length with it, and four Inches broad, and half an Inch thick; and this is the Part which on its Outſide goes againſt the Right-hand ſtandard of the Plow, when 'tis at Work. The other Poſt *b d*, of the ſame Thickneſs with the former, is nail'd in within half an Inch of the oppoſite Edge of this End; to which Poſt alſo C being nail'd, makes the hinder-ſide of this Part of the Hopper. C is four Inches broad, and half an Inch thick, and both it, and the Poſt to which it is to be nail'd, are ſomething longer than its oppoſite ſide, becauſe the ſide B makes right Angles with the Top and Bottom of the Hopper; but the hinder-ſide C makes oblique Angles with the Top and Bottom of the Hopper; and the Reaſon of this is, becauſe when the Hopper is full of ſeed, it may be equally pois'd on the ſpindle; which it could not be without this Bevel, unleſs the Bottom of the Hopper did come as much behind the ſpindle as before it, and that would hinder the Perſon that follows the Drill, from ſeeing the ſeed fall out of the *Seed Box* into the Funnel; and that

Part of the Bottom which is before the ſpindle, cannot be made ſhorter, becauſe that Part of the *Seed-Box* which is before the ſpindle, is (upon Account of it Tongue) much longer than the Part of it which is behind the ſpindle: 'Tis true that when the Hopper is empty of ſeed, it cannot be thus pois'd; but then being ſo light, it does not require it. *e f g h* is a Piece of a Board, nail'd on to that Part of the End A, which is below the Bottom of the Cavity which holds the ſeed, and is commonly plac'd a little croſs the Grain of the Board to which it is nail'd, and ſerves to ſtrengthen it, and keeps the Hole *i* from ſplitting. The upper Edge *e f* of this added Piece of Board, is exactly the Length of the Bottom of the Hopper, whereto the braſs *Seed Box* is faſtened; and this Bottom, together with its *Seed Box* under it, being put into its Place, bears upon this Piece from *e* to *f*, which holds up the right ſide of the Bottom, and keeps it from ſinking downwards; as the lower Ends of the two mention'd Poſts, and the fore and hinder-ſide B and C nail'd to them, prevent its riſing upwards.

The Manner of making the Hole *i*, is as follows: Place the *Seed Box* with its fore End at *e*, and hinder End at *f*, with the Baſe of its Cylinder (or great Hole) againſt this added piece of Board, and its upper Edge exactly the Height of the Edge *e f*; then with a Pair of Compaſſes put thro' the Cylinder of the *Seed Box*, mark round the inner Edge of its Baſe upon the added Board; then take off the *Seed Box*, and find the Center of the mark'd Circle, and then with a Tool call'd a Center-Bit, of the right ſize, bore the Hole quite through the double Board, and this Hole will be in the right Place, and of the ſame Diameter with the ſpindle; but in Caſe there is to be a braſs Wreath on that Part of the ſpindle which is to turn in this Hole, then the Hole muſt be bor'd of the ſame Diameter with that Part of the Wreath which is to enter it, and that may be perhaps near a quarter of an Inch longer than the Diameter of the ſpindle, upon which it is faſten'd.

This End A thus bor'd and ſhap'd, is a Pattern for its Oppoſite, and for the other two Oppoſites of the other Cavity, which holds the ſeed at the other End of the Hopper.

When the Oppoſite of A (with the two like Poſts whereto the fore ſide B, and the hinder ſide C are nail'd, and having a like Piece of Board in its lower Part with a like Hole in it) is added, and when the Bottom (four Inches broad) with its *Seed Box* under it, is thruſt in at *f* by the prick'd Lines until it reach *e*, bearing on one ſide upon the Piece of Board *e f g h*, and the other Edge of the Bottom bearing in like manner upon the oppoſite Piece, then this Cavity of the Hopper which will contain about two Gallons of Seeds will be finiſh'd.

Note, The Bottom muſt make a right Angle with the two fore Poſts, having the ſide B perpendicular to it.

D Is a part of the Board which comes out farther than the Hopper, in order to hold a Bar at *k*; which being faſtened there, and in like manner to the Oppoſite of this Board, this Bar bearing againſt the fore part of the ſtandard, the Hopper and its Wheels are in part drawn by it.

Into the Notch *l* is faſtened one End of a long Bar, which paſſes the whole Length of the Hopper, and holds the upper part of its two Cavities in their Places, as is ſeen mark'd D, in *Fig.* 15.

E is part of the Board which comes before the Hopper, and whereto one End of a piece of Wood is faſtened by Nails or Screws, which bearing againſt the fore part of the ſtandard, and againſt its

Inſide, the Hopper is in part drawn and guided by it, as ſhall be ſhewn in *Fig.* 15.

Fig. 13. Shews the Outſide of the Figure laſt deſcrib'd. A is the ſtandard by which this End of the Hopper is drawn, in the manner as it is here placed. B is one End of the ſpindle paſſing thro' the Hopper and *Seed Box.* C the bottom, having the *Seed Box* faſten'd on to it, with one ſcrew before, and another behind, with their Nuts underneath, and the Heads of their ſcrews very thin, and the Pins ſquare at Top, that they may not turn in the Wood; and their Heads muſt either be let into the Wood, even with the ſurface, or elſe the ſides B, C of the Hopper muſt be cut for theſe Heads of the ſcrews to paſs in under them.

This bottom Board which holds the braſs *Seed-Box*, is four Inches broad, and full half an Inch thick, and at each End a Quarter of an Inch longer than the *Seed Box:* This piece is firſt thruſt in ſliding upon the two added pieces of Board, until its fore End come under the fore-ſide of the Hopper, and its hinder End under the hinder-ſide; then ſetting the Hopper with its bottom upwards, the ſpindle being thro' the *Seed Box*, and Holes of the Hopper, we hold the *Seed Box* hard upon the Bottom, at equal Diſtance from each End of it, whilſt the Holes are bored thro' the bottom, by the Holes at each End of the *Seed Box*; and then the ſcrews being put thro', ſcrew on the Box; and when that is done, we make a Mark upon the bottom-board, with the Compaſſes, on each ſide of the braſs Box, beginning from the Ends of the Axis of the Tongue, reaching as far backwards as is the Length of the Mortiſe: Theſe two Lines or Marks are a Direction for cutting the Hole in the bottom of the Hopper, thro' which the ſeed deſcends into the *Seed Box*, then we pull out the ſpindle, then draw out the bottom, take off the *Seed Box*, and cut the Hole in the bottom in the Manner I'll now deſcribe in *Fig.* 14. where the two prick'd Lines *a b* and *c d* are the lower Edges of the Hole, and the ſame with the two Lines mention'd to be mark'd by the ſides of the *Seed Box*: The prick'd Line *a d* being at right Angles with the two former, is the lower Edge of the fore End of the Hole, and exactly over the Axis of the Tongue, and parallel to it; the prick'd Line *b c* is the lower Edge of the hinder End of the Hole, which is juſt over the hinder End of the Mortiſe, and parallel and equal to the laſt mention'd prick'd Line; theſe four prick'd Lines are the lower Edges of this Hole, contiguous to the *Seed Box*: The two Lines *e f* and *g h* are the upper Edges of the ſides of the Hole, which being farther aſunder than the lower Edges, make the reverſe Bevel of this Hole; which may be determin'd by this, that the ſurface between theſe two upper and lower Edges, being Planes, are inclin'd to one another downwards, in an Angle of about one hundred and thirty Degrees; the two lines *e h* and *f g*, at right Angles with the two laſt mention'd lines, make the upper Edges of the Ends of this Hole; and being nearer together than the prick'd Lines under them, the plane ſurfaces, betwixt theſe two Lines and thoſe two prick'd Lines, ſhew the Bevel of the Ends of theſe, which are inclin'd to each other upwards, in an Angle of about ſixty five Degrees.

This double Bevel effectually prevents the ſeed from arching in the Hole, before it gets into the Mortiſe of the *Seed Box*; and alſo the two upper Edges of the Ends of the Hole, being nearer together than the lower, there is the more Wood left between theſe Edges and the Screws, which hold the Box to the Bottom, whereby the Board is leſs apt to ſplit.

Then the Box being ſcrew'd on to the Bottom, and thruſt again into its Plaee, the ſpindle paſſing thro' both the Hopper and the Box, keeps the Bottom in its Place; then D, in *Fig.* 13. is the imaginary Plane of the Top, or Mouth of the Hopper, being a rectangled Parallelogram, and parallel to the bottom, to which the fore End is perpendicular, and a rectangled Parallelogram of the ſame Breadth.

Fig. 15. Shews the fore ſide of the whole hinder Hopper, with its two Cavities, and all its Accoutrements, except the Wheels. The two Ends A and B being exactly alike, having each of them its *Seed Box* at the Bottom, in the ſame Manner as in the one has been deſcribed. The Bar D holds together the upper Parts of this double Hopper at a right Diſtance, which is, when there is ten Inches clear Room betwixt the two ſingle ones. The Spindle E paſſing through the whole, holds the two ſingle Hoppers by four Wreaths, at the ſame Diſtance below, at they are held by the Bar above.

Theſe four Wreaths are ſcrew'd on to the Spindle, to keep it from moving towards either End, as well as to hold the Hoppers in their Places: Two of which Wreaths are ſeen at *a* and *b*; and the other two are placed on the Outſides, as theſe two are on the Inſides. Before we proceed any farther in this Figure, 'twill be proper to ſhew the Wreaths, which are of two ſorts.

The one in *Fig.* 16. where A is its Hollow, which is circular, and muſt be of the ſame Diameter with the Spindle, and being thruſt on upon the Spindle, till it touch the Board, is faſten'd to the Spindle by a ſmall Screw thro' each of its oppoſite Holes. *a b* ſhews the Breadth of this Wreath, whether it be made of Braſs or Wood; it is little more than half an Inch. *b c d* is the Part of it that goes againſt the Board; the Thickneſs of the Surface of this End which goes againſt the Board, is a Quarter of an Inch, it made with Braſs, but if with Wood, half an Inch; but the Thickneſs of its other End *a e f* is leſs than its End *b c d*, by which means the ſcrews are the more eaſily turned in.

Fig. 17. Shews the other ſort of Wreath, which is always made in Braſs; its Cavity is a hollow Cylinder like the former; when it is on the Spindle, its End *a b c* is thruſt into the Hole of the Board (made wider for the Purpoſe) until *d e f* come cloſe to the Board, and ſtop it from entring any farther; then we ſcrew it on to the Spindle by the Holes, as the other ſort of Wreath is deſcrib'd to be ſcrew'd.

This is the beſt ſort of Wreath; becauſe it keeps the Spindle from wearing againſt the Edges of the Hole, and then the Spindle never has any Friction againſt the Wood in any Part of it; but the other ſort are more eaſily made, (eſpecially of Wood) and the Spindle will laſt a great while in them; or if it be worn out, the Expence of Three-pence, or Four-pence, will purchaſe a new Spindle.

Now I muſt return to *Fig.* 15. where the Spindle E, having its four Wreaths fix'd on it, we turn it round with our Hand, to ſee whether the Wreaths are put on true; and when they are ſo, neither the Spindle nor the Hoppers can move end-ways. Tho' the Spindle be pretty hard to turn round, the Wheels will ſoon cauſe it to turn eaſily; whilſt the Spindle is in this Poſture, we turn the Hopper Bottom upwards, and mark the Spindle for cutting the Notches in the Manner before directed, and then we take off the Spindle, and cut the Notches, and alſo cut each End of the Spindle ſquare, up to a Shoulder at each End, ſo that the Wheels may come eaſily on without Knocking or Thruſting; and then we return the Spindle to its Place, and put on the Wheels, pinning them on with each a long Nail, which being crook'd at the Ends prevents it from falling out, but may be very eaſily pull'd out with the Claws of a Hammer; but we muſt take Care that neither the ſquare Ends of the Spindle, nor the ſquare Holes in the Naves (or Hubs) of the Wheels (into which they enter) be taper, for if they are taper, the Wheels will be apt to work themſelves off.

The piece of Wood, *Fig.* 18. is that which goes over the Standard, and being plac'd in the Hopper, as F in *Fig.* 15. draws that part of the Hopper by its Inſide *a b* bearing againſt the fore part of the Standard; and that part of it from *b* to *c*, being the Breadth of the Standard, bears againſt its inner Inſide, to prevent the Hopper from going any farther towards that End. This piece of Wood is faſten'd to the Boards of the *Hopper*, either by Screws or Nails; this Piece from *d* to *e*, muſt be of ſuch a Thickneſs, that the Standard bearing againſt its Inſide *b c*, may be equidiſtant from each Board, to which this piece is faſten'd. The Part, or Foreſide of this Piece *f g*, muſt be the Length of the Diſtance between Board and Board, to which it is faſten'd, and that is exactly four Inches. Its Thickneſs and Depth muſt be ſuch as may make it ſtrong enough for the Purpoſes intended.

The Piece mark'd *Fig.* 19. is the Oppoſite of the former, and to be placed in the ſame Manner, and as it is ſeen mark'd G, in *Fig.* 15. Obſerving always, that the Part of it, which holds the Hopper from moving end-ways, muſt always be on the Inſide of the Standard; for if theſe Pieces ſhould bear againſt the Outſides of the Standards, the Hopper could have no Play upon them, nor could either of the Wheels riſe up, without raiſing the Share (that was next to it) out of the Ground; but being thus placed, either Wheel may riſe without the other, and without raiſing the Share.

I ſay the more of this, becauſe it is a Point wherein young Workmen are apt to miſtake.

Thus having ſhewn, in *Fig.* 15. how the Hopper is guided and drawn at the lower Part, I come next to ſhew how it is held and drawn at its upper Part; for which the piece of Wood, *Fig.* 20. being of a competent Breadth and Thickneſs, four Inches long, is fix'd in betwixt the Boards with Nails or Screws; and is H in *Fig.* 15. The Standard paſſing up betwixt this and the Foreſide of the Hopper, its Fore-ſurface bearing againſt this Bar, and its Hinder-ſurface againſt the Hopper; ſo that the Hopper may riſe and ſink eaſily upon the Standard at Top, being in the Middle of the Fore-ſide of the Hopper, there will be an equal Diſtance on each ſide, for either Wheel to riſe, without the Standard ſtriking againſt the ſides of the Hopper to hinder its riſing. There is another Bar equal to this, and has the ſame Office, at the other End of the Hopper, mark'd I. Likewiſe the Bar D is of the ſame Uſe with theſe mention'd ſhort Bars, and they help to ſtrengthen one another.

When the Wheels are put on till they reach near to the Wreaths, they will ſtand with their Rings, or Circles, two Foot three Inches aſunder.

We ſet them as near together as conveniently we can; becauſe when they are too wide, they are apt to draw the Plow towards one ſide of the Ridge; and ſometimes when the Ridge is high, the Hopper might bear upon the Funnels, and then the Wheels being carried above the Ground, would not turn to bring out the Seed: And that theſe Wheels may come the nearer together, their Spokes are ſet almoſt perpendicular; ſo that the Wheels are not concave, as other Wheels are. This Hopper is ſhewn, put on upon its Standards, in its Place, in *Fig.* 21. where the mention'd Bar D, which holds the Hopper

per together at Top, is ſeen, as alſo the four Wreaths, and likewiſe the hinder End of the *Seed-Boxes* ſtanding over the Funnels, with their Trunks underneath them. Here alſo the back-part of the fore Hopper is ſeen, with its *Seed Box* ſtanding over the fore Funnel; its Mouth alſo is ſeen at A; as alſo the Top of its Fore-ſide held up by the Thing (*Fig.* 22.) like the Carrier of a Latch, with the Nails in it, which faſten it to the Top of the Fore-ſide of the Hopper, and give Room for either of its Wheels to riſe.

This Fore-hopper may be eaſily deſcrib'd by the Figure of a Box, like the other already deſcrib'd, at its Ends, which are of the ſame ſhape with the Inſide of the Box, *Fig.* 12. but much lower, being ſeven Inches and a half deep, and ſixteen Inches long, and the Breadth of its Bottom is determin'd by the Length of the *Seed Box*, and a little wider at Top, on account of the Bevel which poizes it; it carries no more Seed than one End of the hinder Hopper, but it is capable of holding more; but we do not fill it quite, leſt ſome of the Seed ſhould fly over in Jolting, its Mouth being ſo much longer than of the other.

This Hopper is kept in its Place, from moving end-ways upon the Spindle, by a Wreath fix'd to the Spindle at each End of the Box, in the ſame Manner as has been deſcrib'd for holding the other Hopper. The Wreaths moſt proper for this Purpoſe, are the ſort deſcrib'd in *Fig.* 17. but the other ſort deſcrib'd in *Fig.* 16, and even made with Wood, will ſuffice; but then we muſt take Care to make the Hole at the End of the Hopper of a conſiderable Thickneſs, that it may not wear the Spindle, which by Reaſon of its great Length, is the more liable to bend, and be cut by the Edges of the Holes; which Cutting cannot be prevented but by the

Thickneſs of the Holes, or by ſuch Wreaths as that of *Fig*. 17.

We ſometimes make this Hopper exactly like a common Box, without any part of its Ends deſcending below the Bottom; and in that Caſe we place a narrower piece of Board at each End of the Hopper, like that of *Fig*. 23. in which Figure, the Hole A being put on upon the Spindle, the piece of Board is faſten'd on by a Screw and Nut thro' the Hole B, near the Top of the End of the Hopper, and by another Screw and Nut thro' the Hole C, near the Bottom of the Hopper. Another ſuch a piece of Board,fix'd on in the ſame Manner to the oppoſite End of the Hopper, holds this long Hopper parallel to its Spindle, that paſſes through the Holes of theſe two pieces, and through the braſs *Seed Box*, which is fix'd up to the Bottom, in the Middle betwixt them.

There are two Methods for letting the Seed paſs from a long Hopper into the *Seed Box*. The *firſt* is that of cutting the Hole thro' its Bottom, in the Manner that has been ſhewn in *Fig*. 14. The other is that which cannot be uſed in a Hopper ſo ſhort, as the Boxes of our hinder Hoppers are; but in the Fore-Hopper, or any other long Hopper, we can place the braſs *Seed Box* to a Bottom made for the purpoſe, like that in *Fig*. 24. where there is a piece of Board on the Fore-part of the Hopper from End to End, as *a b*, and another on the hinder part of the Hopper, as *c d*. Then the fore part of the braſs *Seed Box* being placed under the Piece *a b*, is ſcrew'd up to it at *e*, and the hinder part of the *Seed Box* under *c d* ſcrew'd up to it at *f*; then the Bottom of the Hopper being open in the Middle, is ſhut by very thin Boards, *g* and *h*, fix'd up to the mention'd pieces; theſe Boards having their upper Surface even with the upper Edges of the braſs Box, the Seed can no way arch in coming into the Mortiſe of the *Seed Box.* Whichever of theſe two Methods be made uſe of, in a long Hopper, the Bottom muſt be fix'd to the two ſides, by ſmall Bars of Wood of about three Quarters of an Inch ſquare, to which the bottom and ſides are faſtened by Nails, in the Manner that the Ends and Sides of the hinder Hopper are faſtened to their Poſts, which ſtand in their Corners.

We take the ſame Method for cutting the Notches in this Spindle, as has been deſcribed for cutting the Notches in the other Spindle.

But obſerve, that the great Length of this Spindle requires it to be the larger, and we make it of an Inch and three Quarters Diameter, the other being only an Inch and a half; we therefore bore the great Hole or Cylinder of its braſs *Seed Box*, a quarter of an Inch in Diameter larger than of the braſs *Seed Boxes* of the hinder Hoppers; and we commonly make a Notch more in the Circumference of this Spindle, becauſe the Semi-Diameters of its Wheels muſt be as much greater than of the hinder Wheels, as is the Thickneſs of the Plank, and the Ends of the Limbers which are betwixt this Spindle and the upper ſurface of the two Beams.

We make all our Spindles of clear quarter'd Aſh, without Knots or Crooks; and when they are well dry'd, and made perfectly round, and of equal Diameter from one End to the other, by the Prong-Maker, we pay a Penny *per* Foot for them at the firſt Hand, and they will now and then have ſomething more for the largeſt ſize; but we are only curious to have the middle part of this long Spindle exact, for we graft on a piece at each End, which does not require any Exactneſs: The Graftings are ſeen at *a a* at one end, and *b b* at the other end of the Spindle (in this *Fig.* 21.) by four flattiſh iron Rings driven on upon the grafted Parts, as they appear

pear under thoſe Letters in the Middle. Between each Pair of theſe Rings, we drive a ſmall Iron Pin through the Joints at *c* and at *d*, to keep the Grafts from ſeparating end-ways; and if they are not tight enough, we make them ſo by Wedges driven in betwixt them and the Spindle.

This fore Hopper is drawn by the Spindle, and the Spindle is drawn by the two double Standards B and C, betwixt whoſe Forks it is placed, as appears in this Figure: The Diſtance between each Fork, or double Standard, being exactly the Diameter of the Spindle, ſo that the Spindle may have juſt Room to riſe and ſink there, and no more.

The Hopper and Spindle are guided, or kept in their Place, from moving end-ways, by two Wreaths ſcrew'd on to the Spindle, the one at *e*, and the other at *f*; each of which Wreaths bearing againſt the Surfaces of both the Legs of each double Standard, on the ſides next to the Hopper, prevent the Spindle and Hopper from moving towards either End, and yet admit the Wheels, or either of them, to riſe and ſink without raiſing either ſide of the Plow, contrary to what would happen if the Wreaths were placed on the Outſides of the Standards next to the Wheels.

We make theſe Wreaths a little different fom the other ſort of Wreaths, which turn againſt the Holes; we make them of a greater Diameter, leſt they ſhould at any Time get in betwixt the Legs of the double Standards, in caſe the Standards ſhould be looſe, or bend; therefore we make the Diameter of each of theſe Wreaths, at leaſt two Inches and three Quarters; we always make them of Wood, and of a peculiar ſhape, taking off their Edges next the Standards, which Edges would be an Impediment to the riſing of one End of the Spindle without the other. So that for making theſe Wreaths, we may form a piece of Wood of the ſhape of a Skittle-Bow (or an oblate Spheroid) having an Inch and three Quarter Hole bor'd thro' its Middle, and then cut by its Diameter (which is about three Inches) in two Halves, each of which will be one of theſe Wreaths, and they muſt be placed on the Spindle, with their convex ſides bearing againſt their reſpective Standards.

The Diameter of the fore Wheels is about thirty Inches, as the Diameter of the hinder Wheels is about twenty two.

The fore Spindle ſhould be of ſuch a Length, that its ſquare Ends, E and F, may come out three or four Inches farther than the Hubs (or Stocks) of the Wheels; ſo that there may be Room to ſhift the Wheels towards either End; for making ſeveral ſets of Notches, for the Uſe of the *Seed Box.*

Obſerve, tho' the fore Hopper is drawn by its ſpindle, yet the hinder ſpindle is drawn by its Hopper.

The Reaſon of this great Diſtance between the two fore Wheels, is not ſo much for their ſerving, as Marking Wheels to this particular Drill; which being drawn only upon a Ridge, its Top is a ſufficient Direction for leading the Horſe to keep the Rows parallel to one another, if the Ridges are ſo; but if the Wheels were much nearer together than they are, and yet more than ſix Foot aſunder, the Wheels going on the ſides of the next Ridges, would be apt to turn the Drill out of the Horſe-Path towards one ſide, not permitting the Drill to follow directly after the Horſe; and if the Wheels ſhould ſtand at ſix or ſeven Foot Diſtance from one another, then they muſt go in the Furrows which are on each ſide of the ſix-foot Ridge: This would occaſion their Hopper to bear upon the Plank, which would carry the Wheels above the Ground, and no Seed would be turned out of the Hopper, unleſs the Wheels were of an extraordinary Height, and the Height required for them would be very uncertain, ſome Furrows being much deeper than others; but the Tops of contiguous Ridges are generally of an equal Height, whether the Furrows betwixt them be deep or ſhallow; for we ſeldom make Ridges of an unequal Height in the ſame Field, therefore there can be no need to change the Height of our Wheels, that are to go upon the Middle of the Ridges; but if they went in the Furrows, they muſt be of a different Height when uſed for drilling of high Ridges, from what would be required when uſed for drilling low Ridges.

One Reaſon why the hinder Shares are ſhorter than the fore Share (and conſequently the fore-part of their Sheats leſs oblique) is, that they may be ſet the nearer to the Rank; and I have had a Drill with five Shares in the Plank, fourteen Inches aſunder, and four of theſe hinder Sheats following in another Plank, whoſe Shares were leſs than three Inches long; ſo that their Beams were ſet ſo far forwards, that one Hopper (by a Contrivance, that carried the Seed forwards to the fore Rank, and backwards to the other Rank) ſupply'd the Seed to both Ranks of Trunks, and planted *St. Foin* in Rows ſeven Inches aſunder, when the Ground was too rough to be planted with Rows at that Diſtance by one Rank of Shares.

It may be objected, that the fore-part of theſe hinder Sheats might not be oblique enough to raiſe up the Strings of Roots or Stubble, which might come acroſs them in their Way; but this Inconvenience is remedied by the greater Obliquity of the fore Sheat (or Sheats) which clears the Way for the hinder Sheats, by raiſing out of the Ground ſuch Strings, *&c.* which might annoy them; eſpecially in this Wheat Drill, where the fore Share ſo clears the Way of the hinder Shares, that they can take hold of no ſtring in the Ground, except of the Ends of ſuch which the fore Share has looſen'd; and they hanging faſter in the Ground by their other Ends, the hinder Shares ſlip by them without taking hold of them; and the Harrow Tines going after ſo near to the Channels of the hinder Sheats, by the ſame means eſcape alſo from hanging in ſuch Strings.

The Reaſons for placing the one Share and one Hopper before, and the two behind in this Wheat-Drill, are ſo many, and ſo obvious, that it would be but loſing of Time to mention them.

The Limbers G and H, we make of Aſpen, Poplar, or Willow, for Lightneſs; we make them as ſmall and light as we can, allowing them convenient Strength, and the ſhorter they are, the more exactly the Drill will follow the Horſe, without the Hand of him that follows the Drill, whoſe chief Buſineſs is, with a Paddle to keep all the Shares and Tines from being clogged up by the Dirt ſticking to them, and alſo to obſerve whether the Seed be delivered equally and juſtly to all the Channels.

Theſe Limbers ſhould approach ſo near together at their fore Parts near the Chain, that there may be none or very little Room betwixt the Limbers and the Horſe, and therefore muſt be nearer together for a very little Horſe than for a great one: The Horſe, which I have uſed in all my Drills, for theſe many Years paſt, is a little one, about thirteen Hands high, and the fore part of my Drill Limbers are twenty Inches wide aſunder at the Chain.

At *g* on the Outſide of the Limber G, is a ſmall Staple driven in, having one Link on it, which holds a ſmall Hook, which taking hold of different Links of the very ſmall Chain I, raiſes or ſinks the fore part of the Plow to different Heights. But take care to ſet it at ſuch a Degree, that the fore and hinder

Shares may go equally deep in the Ground; and when they do ſo, the fore part of the Limbers ought to be higher than the Traces which draw them.

At *h* in the Limber H, is driven another Staple, which holds the other End of the Chain; or elſe, inſtead of a Chain, me may make uſe of a piece of Cord, one end of which put through this Staple, and ty'd to the Limber, and a piece of Chain of half a Dozen Links faſten'd to the other End of ſuch a Cord, will ſerve as well as a whole Chain, for raiſing and ſinking the Limbers.

He who can by theſe Directions make this Wheat-Drill, may very eaſily make any other ſort of Drill, for planting any ſort of Corn, or other Seeds that are near about the Bigneſs of Seeds of Corn: He may make it with a ſingle Row of Sheats, by placing as many of theſe fore Sheats as he pleaſes in the Plank, which may be longer or ſhorter, as he thinks fit; and he may add a Beam betwixt every two of them, with a Sheat in it, like theſe hinder Sheats, and then the Drill will be double, having two Ranks of Shares. But I muſt adviſe him never to make a Drill with more Shares than will be contained in four Foot Breadth, that is, from the outermoſt on the right Hand to the outermoſt on the left Hand; for ſhould the Drill be broader, ſome of the Shares might paſs over hollow places of the Ground without reaching them, and then the Seed falling on the Ground would be uncover'd in ſuch low Places.

To a Drill that plants upon the Level, Marking Wheels are neceſſary, to the end that every Row may be at its due Diſtance. As in a Drill with five Shares, for planting Rows eight Inches aſunder, four of the five cannot err, becauſe four equal ſpaces are included betwixt the five Shares; but the fifth (which we call the planting ſpace) being on the Outſide unconfin'd, would ſcarce ever be equal, were it not kept equal by the help of the Marking Wheels: The Rule for ſetting of theſe is thus; we compute altogether the five ſpaces belonging to the five Rows, which being in all forty Inches, we ſet the Marking Wheels eighty Inches aſunder, that is, double the Diſtance of all the ſpaces, each Wheel being equidiſtant to the Middle of the Drill, which Middle being exactly over the Horſe-Path, when the Drill is turn'd, the Horſe goes back upon the Track of one of theſe Wheels, making his Path exactly forty Inches diſtant from his laſt Path; by this Means alſo the Rows of the whole Field may be kept equidiſtant, and parallel to one another, ſo that it will be difficult for an Eye to diſtinguiſh the parting Rows from the reſt.

But when two different ſorts of Seed are planted, ſuppoſe a Row of *St. Foin* betwixt every Row of *Barley*, the Rows of which being eight Inches aſunder, and the Barley drill'd by the fore Hopper into the Channels made by the five Shares, and the St. Foin drill'd from the hinder Hopper into the Channels made by ſix Shares, the Marking Wheels muſt be at no greater Diſtance than thoſe above mention'd, where there are only five Shares; becauſe one of the ſix which are for the St. Foin, muſt always return in the ſame Channel, going twice therein; for one Row of Barley would be miſſing, in caſe the parting ſpace ſhould be made by this ſixth Share, and that parting ſpace would have no Barley in it. Therefore 'tis a Rule that whenſoever two ſorts of Seeds are drill'd, the Rows of one ſort betwixt the Rows of the other, there muſt be an odd Share in the Drill, which muſt go twice in one Channel, and the Diſtance of the Marking Wheels muſt be accounted from that Rank of Shares which are the feweſt: It muſt alſo be contriv'd in this Caſe, that each outermoſt *Seed Box* muſt deliver but half the

Quantity of Seed that each of the inner *Seed Boxes* do; becauſe the outer ones going twice in a place, their Channels would otherwiſe have a Quantity of Seed double to the reſt.

In a Drill that has two Spindles, we place the Marking Wheels on the foremoſt, which upon their Account is the longeſt; but if we ſhould uſe the Wheels of the hinder Spindle as Marking Wheels, then that muſt be the longeſt, and ſo the fore Wheels (their Semi-Diameters being much longer than the Semi-Diameters of the hinder Wheels, and their Spindles ſhorter) would ſtrike againſt the hinder Spindle, unleſs it were ſet farther back than is convenient.

When Ground is harrow'd the laſt Time before 'tis to be drill'd, we contrive that the Harrows may not go directly towards the ſame point that the Drill is to go, leſt the Track of the Marking Wheel ſhould be exactly parallel with the Track of the *Harrow Tines*, which might make it difficult to diſtinguiſh the Track of the Wheel from that of the *Harrow Tine.*

He that has not a great Quantity of Ground to plant with St. Foin, and does not plant it betwixt Rows of Corn, will have Occaſion for no other Drill, than this *Wheat Drill* deſcrib'd in *Fig.* 21. He may plant his Rows at fifteen Inches aſunder, by the hinder Hopper and its Shares, without removing them, the fore Hopper being taken off; or elſe you may plant three Rows at ſixteen Inches aſunder, by ſetting the Beams and their *Seed Boxes* and Hoppers at thirty two Inches aſunder inſtead of fifteen, equidiſtant from the Fore-ſhare; and then the Marking Wheels, which are thoſe of the Fore-ſpindle, muſt be eight Foot aſunder, to wit, double to the ſpaces of the three Shares, which are three times ſixteen Inches (or four Foot); or you muſt ſet the two hinder

Beams, &c. at what Diſtance you pleaſe, ſetting the Marking Wheels to correſpond with them; but then the Harrow muſt be alter'd, and both its Legs and Tines muſt change their Places in the Head, the Legs for guiding it exactly, and the Tines to follow in all the three Rows, which will require a third Tine to be added in the Middle, between the other two; but without any other Alteration than that of taking off the fore Hopper, and that of leſſening the *Seed Paſſages* of the hinder Hopper by the *Setting Screws.* My Man planted me ſeveral Acres of *St. Foin* with my Wheat Drill two Years ago, the Rows being all fourteen Inches aſunder; it is now an extraordinary good Crop.

In Caſe the Shares, being only three, ſhould in fine Ground, go ſo deep as to endanger the burying of the Seed, the beſt Remedy to prevent this fatal Misfortune, is to place a triangular piece of Wood, like thoſe in *Figures* 25 and 26. The firſt of which ſhews one ſide thereof, with the Nail by which it is to be nail'd into the lower part of the Trunk, with its moſt acute Angle uppermoſt; the other in *Fig.* 26. ſhews the ſame, and its back-ſide *a b*, that is to be nail'd to the back of the Sheat, being of the ſame breadth with it; its Bottom *b c* being the breadth of the Plates, on their Inſide, the Angle *c* coming out backwards, juſt as far as the Plates; the Depth of this piece from *a* to *c* is uncertain, becauſe the Plates of ſome Trunks are broader than of others. the Uſe of this piece is to fill up the lower part of the Trunk; ſo that the Seed dropping upon the oblique ſide of this piece of Wood, may by it be turn'd into the Channel, after ſo much Mould is fallen into it, as will ſufficiently leſſen its Depth, whereby the Danger of burying the Seed is avoided: And ſuch a piece of Wood placed into each Trunk, I think, is preferable to Ground-Wriſts, which are commonly uſed for this Purpoſe; becauſe the Ground-Wriſts leave the Channels too wide and open.

But when only the two hinder Sheats are uſed for *St. Foin*, we can make their Channels the ſhallower, by ſinking the Limbers by their Chain, ſo much as that the Plow bearing moſt upon the fore Share, the hinder Shares will go the ſhallower.

When we drill hilly Ground, both up and down, we cover the hinder parts of all the Trunks, from their Tops, to within two or three Inches of the Ground, to prevent the Seed's falling out far behind the Trunk, in going up Hill; and this we do either by a piece of Leather nail'd to each ſide of a Sheat, the Middle of the Leather bearing againſt the hinder part of the Plates (or Trunk); or ſometimes inſtead of Leather we uſe Tin.

Every Trunk being thus enclos'd behind, we can drill up and down a Hill of a moderate Aſcent; but when it is very ſteep, we never drill any Thing but *St. Foin* on it, and that by a Drill made for the purpoſe, ſo very light, that a Man may carry it up the Hill at his Back, and draw it down after him: This Drill has five or ſix Sheats in one Row (with the Harrow behind them). Their Shares being extremely ſhort, the Standards which draw the Hopper muſt be ſet perpendicular to the Horizon, when the Drill is coming down, rather than to the ſurface of the ſide of the Hill; the Funnels muſt alſo correſpond with the Standards.

Some, inſtead of theſe Sheats, make uſe of hollow wooden *Harrow Tines*, thro' which the ſeed deſcends: But theſe I do not approve of; becauſe where the Ground is hard, and not fine, they riſe up, and make no Channels for the ſeed, and then it lying uncover'd will be malted.

When a Drill has only one Rank of Shares, we ſcrew on the Harrow by its Legs, to the Inſides of the two outſide Sheats, as near as we can to their Harſore Shoulders, leaving ſufficient Room for the Harrow to riſe and ſink, in the ſame Manner as when it is drawn by the Beams.

CHAP. XXIV. *Of the* Turnep-Drill.

PLATE 5. ſhews the whole Mounting of a *Turnep-Drill. Fig.* 1. is a Plow but little differing from the *Drill-Plow* laſt mention'd, A, A are the two Limbers, differing in nothing from the other, except that they are lighter, not being above two Inches Diameter, behind the Bar; they are drawn in the ſame Manner as the other. Their Bar B is diſtant from the Plank three Inches, being ſhoulder'd at each End, with a very thin flat Tenon, paſſing through each Limber, and pinn'd on their Outſides as at *a a*. We do not pin in this Bar thro' the Limbers, leſt the Holes ſhould make theſe very ſmall Limbers the weaker in that part. C, the Plank, two Foot and an Inch long, five Inches broad, and an Inch and a Quarter thick. D, D, the two double Standards, or two Pair of Standards, placed into the Plank with Shoulders above, and Tenons pinn'd underneath the Plank, and are thirteen Inches high above it: Theſe ſerve for a pair of Marking Wheels, when Turneps are drill'd on the Level, to keep the Rows all parallel,

and at what Diſtance you pleaſe, by ſetting them according to the Rule already laid down.

Sometimes we place the double Standards into the Plank of the *Wheat Drill*, in the ſame Manner that theſe are placed.

We take off the inner Edge of each Standard at the Top, as at *b b* and *b b*, for the more eaſy Admiſſion of the Spindle of the Marking Wheels into the Forks: This Spindle is kept in its place by two of the ſame ſort of Wreaths, and placed in the ſame Manner as thoſe deſcrib'd for the fore *Hopper* of the *Wheat Drill.*

Such Marking Wheels are neceſſary for drilling upon the Level; but not for drilling upon Ridges.

E is the Beam, two Foot two Inches and a half long, four Inches broad, and two Inches thick; it is thus broad, that the Screws which hold on the croſs piece F, may be the farther aſunder: The Screws muſt be placed as near as may be to the Outſides of the Beam, and at equal Diſtance from each ſide of the croſs piece, by which Means the Standards are kept the firmer from Turning.

The Diſtance between the Plank and the croſs piece is eleven Inches, the Breadth of the croſs piece is two Inches and a Quarter. This croſs piece is ſhewn a-part in *Fig.* 2. where its two Standards A, B are each ſeventeen Inches long (or high) and each on its Fore-ſide and Hinder-ſide one Inch and a Quarter broad, and nearly three Quarters of an Inch thick; they are ſhoulder'd and pinn'd into the croſs piece at *a b*. The croſs piece is thirteen Inches and a half long, and one Inch and a Quarter thick in the Middle from *c* to *d*; but for about an Inch on the Inſide of each Standard is two Inches and a half thick, that the Standards may have the more Wood to ſupport them, and that the Hopper bearing upon the thicker parts of the croſs piece may be held up about the Funnel, that the Fork of the braſs Spindle may not ſtrike againſt it, when the Plow is taken up to be turn'd, there being a little more than a Quarter of an Inch of the Breadth of the croſs piece behind the Standard, for the Hopper to reſt on.

The whole Diſtance between the Standards, is nine Inches and a Quarter. The Standards muſt be exactly perpendicular to their croſs piece: Their Tops are drawn up each to a Point, as at *e* and *f*, by which the Hopper is the more eaſily put on upon them.

The Funnel, Sheat, Share, and Trunk, are the ſame of thoſe in the *Wheat Drill*, except a few Differences. As G in *Fig.* 1. is the ſame of the Foreſheat of the Wheat Drill, with its Accoutrements, only it is lower, being but eight Inches high from the bottom of the Share up to the Beam, and the Plates of the Trunk are ſomewhat narrower; its Tenon paſſes thro' the Beam, and comes up above it, betwixt the Funnel and the croſs Piece, and there is pinn'd in thro' its Hole above the Beam. There is no want of Wood behind the Sheat, the Funnel not being cut in the Beam, but placed upon it.

The Funnel is ſhewn a-part in *Fig.* 3. and is two Inches deep, four Inches ſquare at Top; its four ſides terminating at a Hole in the bottom, half an Inch broad from *a* to *b*, and near an Inch long from *c* to *d*, which Length is divided in the Middle, by the upper Edge of a braſs Spout, which divides the Hole into two equal Parts (or Holes), each of which is about half an Inch ſquare. This Funnel being ſcrew'd on upon the Beam by two Wood-ſcrews, entring at two oppoſite Corners of the Funnel, as at *c d* in *Fig.* 1. ſo that the Seed may drop from the *Seed Box* upon the right ſide of the Funnel at *e*, which being about half an Inch diſtant from the Partition, and equidiſtant from both Holes, the Seed rebounding is pretty equally diſtributed to each of the Holes.

The fore part of the foremoſt Hole, being equal with the Back of the Sheat, the Beam being cut thro'; ſo that the Back of the Sheat, and the fore part of the Hole thro' the Beam, and the fore part of this Hole, make one plane Surface, whereby the Seed that falls into this foremoſt Hole, deſcends to the Ground, near the Back of the Sheat, thro' the Trunk.

And the Seed which falls into the hinder Hole, is convey'd obliquely backwards thro' part of the Beam, by a ſhort thin braſs ſpout, whoſe Diameter in the Inſide is ſomewhat more than half an Inch; but the fore part of it, which divides the two Holes, deſcends firſt perpendicularly half an Inch, and then turns off backwards, and there the ſpout begins to be round; its joining is on its hinder part, to the end that the Seed never running upon it, cannot be ſtop'd by it. The lower End of this ſpout, ends at the lower ſurface of the Beam, a little behind the Plates of the Trunk, which Hole is ſeen at *a* in *Fig.* 4. where this Hole delivers the Seed down into the Spout A, when it is drawn up into its place by the ſtring B drawn thro' the Hole at *b* in the End of the

Beam, and there tyed until it ſtand in the Poſture in which it is ſeen at *f* in *Fig.* 1.

The ſhape of this Spout is better ſeen in *Fig.* 5. where A is the Spout, four Inches long, a full Inch Diameter in the Inſide; its lower End is circular, but its upper End B is cut at oblique Angles, ſo that when it is drawn up to its Place, its Edges will touch the lower ſurface of the Beam, and encloſe the lower End of the other ſpout within it; it is made of thin hammer'd Braſs (as is the other). The Edges of the Piece of Braſs which make this Spout, are join'd on its hinder part, for the ſame Reaſon that they are ſo in the other Spout. At *b* there is a Jag cut in one of theſe Edges, and rais'd upwards, by which Jag the ſtring being tied on the ſpout juſt below, is hindred from ſlipping upwards.

Joining to the higheſt part, and made with part of the ſame piece of Braſs, turn'd back from the end of the ſpout, is its Hinge C, near three Quarters of an Inch long in its Hollow.

D is a thin piece of Iron, half an Inch broad, and a little longer than the Top of the Sheat, by which the ſpout is held up; this piece of Iron is riveted by a Rivet paſſing thro' a Hole at *c*, and through the Sheat, juſt before the Trunk, and through another piece of Iron on the oppoſite ſide; both the pieces of Iron, with their upper Edges touching the Beam, being thus riveted to the Sheat.

The Spout is pinned in by the Screw E, paſſing as by the prick'd Line F thro' the Hole G, and alſo thro' the Hinge C, and ſcrew'd into the Hole of the oppoſite piece of Iron, correſponding with the Hole G; and then it will appear as in *Fig.* 4.

Inſtead of theſe pieces of Iron, we ſometimes uſe pieces of Wood, a little broader and thicker, nail'd on the Sheat.

The Uſe of this Spout is for carrying half of the Seed backwards, ſo that it may drop upon the Channel after the Earth is fallen into it; by this means the Seed lying very ſhallow, being only cover'd by a little Earth rais'd by the Harrow, by its Shallowneſs comes up in moiſt Weather ſooner than the other half, which lies deeper in the Ground; but if the Weather be dry when planted, the deeper half, by the Moiſture of the Earth from the Dews, will come up firſt, and the ſhallow half will not come up 'till Rain come to moiſten it; ſo that by the ſhallow or deep, the Turnep-Fly is generally diſappointed.

Fig. 6. Shews one of the Tines of a *Drill-Harrow* made of Wood: Its Edge *a b* is made roundiſh at *b*, by which means it raiſes the Earth on its ſides; but does not drive it before: This Edge from *a* to *b* is ſix Inches long; from *b* to *c*, being its Bottom, is one Inch and a Quarter; from *c* to *d* is the Back, an Inch and a half thick at Top, gradually tapering downwards to *c*, where it is half an Inch thick, being ſhoulder'd all round; It has a flat Tenon A, which paſſes through a Mortiſe in the Harrow-Head; the Length of which Mortiſe is parallel with the Length of the Harrow-Head, into which it is held by a Pin, paſſing thro' the Hole of the Tenon, above the Harrow; as may be ſeen in *Fig.* 7. at *a*; and its Fellow at *b*.

These two Tines are eight Inches aſunder at their Points, and ſix Inches and a Quarter aſunder at their upper Parts, juſt under the Harrow-Head. The fore Edge of the Tine A inclines a little to the left, as the Edge of the Tine B doth to the right.

Fig. 8. Shews one of the Legs of the Harrow. At *a* is ſeen the round Tenon, which paſſes through the Harrow-Head up to its Shoulder, and is pinned in thro' a Hole of the Tenon juſt behind the Harrow-Head; upon this Tenon the Harrow-head may turn: The other End has a Hole at *b*, thro' which it is pinned on to the Beam. The Length of the Leg from the Shoulder at *a*, to the Hole at *b*, is twenty Inches. Its Thickneſs is an Inch and a Quarter, and its Breadth an Inch. The two Legs are ſeen mark'd C, D, in *Fig.* 7. They bend down in the Middle, to give the Harrow the more Room for riſing and ſinking; they are parallel to each other, and diſtant a little more than the Breadth of the Beam, that they may have Liberty to move thereon, when one End of the Harrow-Head ſinks lower than the other, by the Unevenneſs of the Ground.

The Harrow is pinned on to the Beam by the Iron Pin *Fig.* 9. paſſing thro' the Hole of the Leg at *g*, and thro' the Beam, and alſo thro' the other Leg on the other ſide of the Beam, where the Screw at the End of the Pin has a Nut ſcrew'd on it. This Pin is round from its Head all the Way thro' the firſt Harrow-Leg, and through the Beam; but all that Part of the Pin which is in that Leg againſt which the Nut is ſcrew'd, muſt be ſquare, whereby that part being bigger than the round part of the Pin, and then the Hole in the laſt mention'd Leg, cannot turn in the Hole of that Leg; for if it did, the Nut would be ſoon unſcrew'd by the Motion of the Harrow; but the Pin muſt have Room to turn in the other Leg, and in the Beam. This ſquare part of the Pin is ſeen at *a*. *Fig*. 9. The whole Length of the Pin, from its Head to the End of the ſquare Part at *a*, where the Screw begins, is of the Thickneſs of the two Legs, and of the Breadth of the Beam.

We ſometimes ſet the Legs of the Harrow two Inches wider aſunder, by making them each an Inch thicker at their fore Ends in their Inſide, and reaching five or ſix Inches behind their Iron Pin; theſe thicker parts bearing againſt the Beam, keep the hinder part of each Harrow Leg an Inch diſtant from the ſides of the Beam, whereby the Harrow-Legs are ſix Inches aſunder, inſtead of four, by means of theſe added Thickneſſes.

When a Drill is taken up to be turn'd, the Perſon that does it, takes hold of the Harrow-Head, and lifts it up; the Legs of the Harrow bearing againſt the croſs Piece, ſupport the whole Weight of the Drill.

When the Harrow does not go deep enough, we tie a Stone upon the Middle of the Harrow-Head, by a String that paſſes through the Holes at *b*. All the Wood of this Plow and Harrow is Aſh, except the Limbers.

The Hopper of the Turnep-Drill is very different from thoſe already deſcribed: It conſiſts of a Box placed into the Middle of a Carriage; which Box is deſcrib'd in all its Parts, lying open with their Inſides upwards in *Fig*. 10. A is the fore ſide of the Box, five Inches and a half deep, and ſix Inches and a half long. B, the hinder ſide of the Box, oppoſite to the former, and of equal Dimenſions.

Each End of the Box is made with three pieces of Board, of which, C the uppermoſt is three Inches and a Quarter deep, and five Inches long, which Length is the Breadth of the Inſide of the Box. The End of the Piece C, when in its Place, ſtands againſt the prick'd Line *a b* in the fore ſide A. The other End ſtanding againſt the prick'd Lines in B, which is oppoſite to, and correſponds with the prick'd Line a *b*. The fore ſide, and hinder ſide, being ſcrew'd to the Ends of this Piece by four Screws.

The Piece D is two Inches and a Quarter broad, and of the ſame Length with the Piece C, and ſcrew'd up to the Bottom of it with two Screws; and then its End will bear againſt the prick'd Line *b c*, and that which is oppoſite to it in the Side B.

E Is the lower piece of this End, and an Inch and a Quarter broad; its End is to ſtand againſt the prick'd Line *c d*, and its other End at the oppoſite prick'd Line in B. The Piece D muſt be ſcrew'd upon the upper Edge of the piece E, as the Bottom F muſt be ſcrew'd up to its Under-edge, which will ſtand upon the prick'd Line *e f*. The three Pieces G, H, I, being oppoſite to C, D, E, and of the ſame Dimenſions with them, placed in the ſame Manner, make the other end of this Box. At *g* in the Bottom F, appears the Hole which is over the Mortiſe of the braſs *Seed Box*, the Shape and Size of which Hole may be ſeen by the prick'd Lines upon the Flaunches B, C, of *Fig.* 9. in *Plate* 2. The foremoſt End of which Hole, reaches almoſt as far forwards as the End of the Axis of the Tongue of the braſs *Seed Box*, and its Hinder-end almoſt as far as the Hinder-end of its Cover. The Bottom F being of the ſame Length with C, D, E, and their Oppoſites, bears againſt the prick'd Line *d b* of the fore ſide A, and againſt the oppoſite prick'd Line of B. The Length of this Bottom F is the Breadth of the Inſide of the Box, and its Breadth reachs to the Outer-edges of the Pieces E and I, being three Inches and a half.

All the Jointings of theſe Pieces muſt be at right Angles, and ſo cloſe, that no Seed may run out at them. All the Pieces are of Board, full half-inch thick, except the Bottom which is thinner.

Fig. 11. Shews the Bottom of the Box with its Under-ſide uppermoſt, where the light part A is the bottom Board, covering the two end Boards E and I in *Fig.* 10. The dark parts B and C, are the Under-ſides of D and H, in *Fig.* 10. At *a* is the Fore-end of the braſs *Seed Box* ſcrew'd up to this bottom Board. At *b* is the hinder end of the braſs *Seed Box* ſcrew'd up in like manner, the Outer-edge of the Flaunch of the *Seed Box* being even with the Edge of the bottom Board; the end of the braſs Spindle, with its Fork, appears at C.

Fig. 12. Shews this Box ſtanding upon its Bottom, with its Hinder-ſide laid open. At *a* is the Hole in the bottom, under which the braſs *Seed Box* is faſten'd, with ſmall iron Screws, ſquare near the Heads, paſſing thro' the bottom, and through the Holes of each end of the braſs Box, with their Nuts underneath. The Pins muſt touch all the ſides of the Holes in the Braſs, to prevent the *Seed Box* from moving any Way.

A Is the Fore-ſide of the Box. B the Hinder-ſide lying down. C is the Piece H of *Fig.* 10. which makes a ſort of Shelf in the Box at its Left-end. D at the Right-end, makes another like Shelf, underneath which, the Fork of the braſs Spindle is turn'd by the Crank in the end of the wooden (falſe) Spindle. By means of theſe Shelves, there is Room for the two wooden falſe Spindles to come the further into the Carriage, without leſſening the upper Part of the Box. E and F are the two Ends of the upper Part of the Box, made by the two Pieces G and C of *Fig.* 10. When the Hinder-ſide B is rais'd up and ſcrew'd to theſe Ends, the Box is compleat.

We put a Lid upon this Box, which is hing'd on to its right or left End. This Box (having the braſs *Seed Box* at its bottom) is to be placed into the Middle of a Frame or Carriage.

Fig. 13. Shews the Inſide of the Carriage lying down. A is the hinder ſide, eighteen Inches long, Dove-Tails and all, and ſix Inches broad. B the fore ſide, of the ſame Length with the hinder ſide, and eleven Inches broad; this five Inches greater Breadth than the hinder Part is, becauſe a greater Height is required on the fore ſide, on account of the Hopper's being drawn, and the Plow held up by that and the Pieces that muſt be fix'd to it. C, D are its two Ends, ſix Inches long, beſides their Dove-Tails, and ſix Inches broad. E and F are two Pieces each ſix Inches long, whoſe Ends are to ſtand againſt the prick'd Lines *a b* and *c d* of the hinder ſide, and their other Ends againſt the prick'd Lines in the fore ſide, which are oppoſite to theſe. The breadth of each of theſe Pieces is four Inches; when they are in their Places, their lower Edges come even with the bottom of the Carriage. Their Uſe is to ſupport the Ends of the Spindles, which come juſt thro' their Holes, after each of them have paſſed their Hole at its reſpective End of the Carriage.

All this Carriage is made of Board ſull half-inch thick: The Ends C and D are made of double Thickneſs by another piece of Board added to each, that covers all their Inſides, except their Dove-Tails. Theſe Boards with which they are lin'd, are nail'd to them, with their Grain going a different Way, and croſsing the Grain of the Board of the End, either at right or oblique Angles. This prevents the Holes from ſplitting out, and makes the Holes of a double Thickneſs, whereby the Spindle is the leſs worn by them, in Caſe there are no braſs Wreaths to enter them.

The Middle Pieces E and F are lin'd by their whole Surfaces, in the ſame Manner as the Inſides of the Ends are lin'd.

When theſe Ends and Middle Pieces are in their Places, a wooden Cylinder of the exact Diameter of the Holes, is thruſt through all four, to hold them exactly true, whilſt the Ends and Middle Pieces are all ſcrew'd faſt into their Places.

The prick'd Lines are drawn all round the Carriage, thro' the Centers of the Holes, and at equal Diſtance from the bottom of the Carriage, which is an Inch and three Quarters and the one eighth of an Inch. This prick'd Line is a Direction how high to nail on the Ledgers G and H, whereon the Box is to ſtand; and the Diſtance the upper ſurface of the Ledger muſt be above the prick'd Line, is the Semi-Diameter of the braſs Spindle; and the Thickneſs of the braſs Box above the Spindle, or which is the ſame Thing, the Diſtance between the Center of the great Hole of the braſs *Seed Box*, and the Plane of the Top of its Mortiſe, being half an Inch and half a Quarter, ſtrike a Line above the prick'd

Line parallel to it, at this Diſtance above, and then nail on the Ledger, with its Upper-edge at this Line. This with its oppoſite Ledger plac'd in the ſame Manner, will ſupport the Box with the Axis of the Spindle of the *Seed Box*, at equal Height with the Centers of the Holes of the Carriage; ſo that if thoſe Holes are parallel to, and equidiſtant from the fore ſide and hinder ſide of the Carriage, and the Axis of the braſs Spindle be placed in the like Manner parallel to, and equidiſtant from the fore ſide and hinder ſide of the Box; then when the Box is thruſt down in its Place upon theſe Ledgers, and the wooden (falſe) Spindles are plac'd into their Holes, their Axes will fall into a ſtreight Line with the Axis of the braſs Spindle, as they ought.

Fig. 14. Shews the Carriage laid open. A is its back ſide lying down. B is its fore ſide ſtanding up. C is the ſquare end of the left (falſe) Spindle, whereon a Wheel is to be put up to the ſhoulders of the ſpindle, quite cloſe to the ends of the Carriage. This ſpindle being an Inch and a half Diameter, is held in its Place, and kept from moving end-ways by two Wreaths; the one at *a*, bearing againſt the Inſide of the end of the Carriage, the other Wreath at *b*, bearing againſt the left ſide of the middle Piece; which Wreath keeps the ſpindle from moving towards the right Hand, as the other does from moving towards the left. D is the ſquare end of the other wooden ſpindle, whereon a Wheel muſt be placed in the ſame Manner as the other Wheel. This ſpindle is kept from moving end-ways by two Wreaths, in the ſame Manner as the other ſpindle is; but this right-hand ſpindle, being that which turns the braſs ſpindle by its Crank, which enters the Fork, ſhould have its Wreaths of braſs like thoſe deſcrib'd in *Fig.* 17. *Plate* 4. Part of which Wreaths entring about three Quarters of an Inch into the Hole of the end and middle Part of the Carriage, being firmly ſcrew'd on to the Spindle, prevent the Friction that would otherwiſe be betwixt the Wood of the Spindle and the Wood of the Holes; which Friction wearing the Wood of both, would in Time cauſe the Spindle to be looſe in its Holes, whereby its Axis would deviate from the ſtreight Line it ſhould make with the Axis of the braſs Spindle, and make an Angle with it, and then the Crank would change its Place in the Fork at every Revolution of the Wheels; and if the Hole ſhould be worn very wide, and the Spindle worn much leſs, the Crank might let go the Fork; but when the Wood is of this Thickneſs, and each Hole has Wood in it, with its Grains pointing different Ways, it would be many Years before the Holes would become large enough for this to happen, tho' only wooden Wreaths were uſed; and as to the two Wreaths of the left Spindle, they may be of Wood, becauſe tho' that Spindle ſhould grow looſe, it is no Damage, for it only ſerves to bear up that end of the Carriage; but he that has this ſort of braſs Wreaths for the hinder-Hopper of a Wheat-Drill, may take them thence, and place them upon theſe Spindles, and remove them again to the Wheat-Drill when that is uſed, for that and the Turnep-Drill, are very rarely, or never, uſed at the ſame Time.

E Is the iron Crank, plac'd into the falſe Spindle, in the Manner ſhewn at H in *Fig.* 5. of *Plate* 2. for turning the braſs Spindle by its Fork; but take Care that the end of this wooden Spindle, do not approach nearer to the end of the braſs Spindle than the Diſtance of half an Inch, leſt if the inner Wreath ſhould grow looſe, the wooden Spindle might bear ſo hard againſt the braſs one, as to wrench the *Seed-*

Box down from the Wood, and then the Seed might run out betwixt the *Seed Box* and the Bottom to which it is ſcrew'd.

When the hinder ſide A is ſcrew'd up againſt the ends and middle Pieces, then the Box deſcrib'd, being thruſt down into the Carriage, and ſtanding upon the deſcrib'd Ledgers, and at that Diſtance from each end of the Carriage, that the Seed may drop on the ſide of the Funnel, as is before deſcrib'd; the Box is kept in its Place by one Screw paſſing thro' its Back, and the back ſide of the Carriage.

The Notch F is cut in the bottom of the hinder ſide of the Carriage, up to the bottom of the Ledger, for the Convenience of ſeeing the Seed drop into the Funnel.

The round Notch G is made in the bottom of the fore ſide of the Carriage, to make Room for one's Hand to go in there, and turn the *Setting Screw* without taking off the Hopper from the Standards.

This Box and Carriage, ſo fix'd together, compoſe the Turnep-Hopper, which is drawn, and guided, and alſo holds up the Plow by two hollow Pieces of Wood ſcrew'd on to the Outſide of the fore Part of the Carriage; their ends H and I appearing a little above the Carriage.

One of theſe hollow Pieces of Wood is ſhewn in *Fig.* 15. The breadth of its Hollow muſt conform to the breadth of the Standards, which are one Inch and a Quarter broad; but we muſt allow about a Quarter of an Inch more in the Hollow for ſwelling of the Wood. The Depth of the Hollow muſt be the Thickneſs of the Standard that is to go in it, allowlowing about the eighth of an Inch for ſwelling of the Wood. The Hollow ſhould be a little deeper in the middle than at each end; becauſe the Standard ought not to bear againſt any Thing, except at, or near, the upper and lower Part of the Carriage. Altho' the end of theſe Pieces come a little higher than the Carriage in this Hopper, yet I think it is better that theſe hollow Pieces come no higher than even with the Top, nor deſcend any lower than even with the bottom of the Carriage, and then the Length of each of theſe Pieces need be no more than eleven Inches, which is the whole Depth of the Carriage.

The Wood on each ſide of the Hollow, ſufficient for the Holes *a*, *a*, *a*, *a*, muſt be about half an Inch broad. The beſt Way for fixing them on, is whilſt the Standards are in them, placing a ſmall Piece of Wood at each Corner of the Hollow, betwixt the Standard and the Wood, to the end that there may be no more Room on one ſide of a Standard than on the other ſide; then ſcrew them on (parallel to and equidiſtant from their reſpective Ends of the Carriage) by four ſmall Screws each, the one at *c*, *c*, *c*, *c*, and the other at d, d, with two below; the Heads of theſe Screws being on the Inſide of the Carriage, and their Nuts on the Outſides of the hollow Pieces; then pull out thoſe little Pieces of Wood, that were to keep the Standards in the middle of the Hollows, whilſt the Holes for the Screws were bored, and then the Turnep-Hopper is finiſhed, and being put on upon the Standards A, B, in *Fig.* 16. is ready to go to Work; and in this Figure the whole Turnep Drill may be ſeen as in the Proſpect of a Perſon following it at Work, except that this Figure has not the double Standards, nor Marking Wheels; becauſe we never uſe them for drilling

Turneps, except it be on the Level, which we very rarely do.

The Circles of the Wheels of this Hopper go twenty five Inches aſunder; were they farther aſunder, they would not go ſo well upon the Ridges; or were they nearer together, they might not hold up the Plow ſo ſteadily, but that one Wheel might happen to be rais'd from the Ground, by the deſcending of the oppoſite Limber; and if it ſhould happen to be the Wheel that turns the Crank, no Seed would be deliver'd out whilſt the Wheel was rais'd above the Ground; ſometimes we uſe Wheels of twenty ſix Inches Diameter, ſometimes thirty, and at intermediate Diameters, with this Hopper.

The beſt Wood for making all ſorts of Hoppers is Walnut-Tree or Elm: Our Beams and Standards we make of Aſh.

What is meant by Wood Screws, are taper Screws made with Iron, having very deep Threads, whereby they hold faſt when ſcrew'd into Wood, and their Points will enter into ſoft Wood without boring any Hole for them into the Wood they are to take hold of; but near their Heads they are round, and have no Thread, and that Part of them muſt always be in a bor'd Hole thro' that part of a Board that is to be drawn cloſe.

If the Standards ſhould be much ſwollen by being wet, it may be proper to anoint them with Soap.

In drilling, when the Wind is very ſtrong, and the Hopper goes high above the Funnel, the Seed might be blown over it, if we did not take Care to guard it from the Force of the Wind; and for doing this there are many Ways: Sometimes we nail a piece of Linen Cloth round the ends, and the fore ſide of the Hopper, or elſe we nail on a piece of old Hat, or Shoe-Leather, round the edges of the Funnel, to raiſe it higher; or if the Hopper go a great deal above the Trunk, we nail up a Pipe of Leather to the wooden Bottom of the Box, which Pipe being about an Inch wide at bottom, protects the Seed from the Wind, till it arrives ſo near the Funnel that the Wind cannot blow it over.

If we would have a long Hopper, to plant many Rows at once, of Clover or other fine Seeds, 'tis eaſy to make each of theſe wooden (falſe) Spindles turn two or three braſs or iron Spindles; but then, as in all other Caſes, where the ſame Hopper is to ſupply more than one Channel with Seed, each of its Weeels muſt have Liberty to riſe without the other, as thoſe of the hinder Hopper of the Wheat-Drill do.

Chap. XXV. *Of the* Hoe-Plow, &c.

PLATE 6. *Fig.* 1. Is the *Hoe-Plow* in a ſide View. A is the Beam and *Plow-Tail*, being much the ſame with that of the common Plow deſcrib'd in *Fig.* 1. of *Plate* 1. The Beam of ſuch a common Plow being cut off, and ſcrew'd up to this Plank, and its Limbers, might make a *Hoe-Plow*. The Share of this, from its Tail to the fore part of its Socket, is two Foot one Inch long, and from thence to the end of the Point, ten Inches and a half; This is the Meaſure of the under ſide of the Share. B is the Plank two Foot ſeven Inches and a half long, two Inches and a half

thick, and nine Inches broad. C, D, are the Nuts of the two Screw-pins, which hold up the Beam to the Plank. E is the Nut of the Draw-pin, which Pin has a Crook underneath, whereto one of the Links of the ſhort Chain of the Whipper is faſten'd for drawing the Plow; the only Uſe of this Nut, is to hold the Pin from dropping out by its own Weight, and that of the Chain and Whipper; but often, to avoid the Trouble of ſcrewing and unſcrewing the Nut, we ſupply its Uſe by a ſquare Pin a little bigger than the Hole, which we drive up by a Hammer, ſo tight, that it may not drop out of itſelf; but can eaſily be driven out by a few blows of the Hammer, as often as 'tis neceſſary to remove it into another Hole. F, G are the two Limbers; they are ſcrew'd on to the Plank by four Screws and Nuts: The Under-ſurface of the Limbers by their whole Length are parallel to the Plank, and to the Upper-ſurface of the Fore-end of the Beam, contrary to the Manner of placing the Limbers of the Drill-Plows; becauſe their Planks being always parallel to the bottom of their Shares, if their Limbers were parallel to their Beams, as theſe are, the Fore-ends of their Limbers would not be elevated higher than the Plank, but would go within a Foot of the Ground, inſtead of being elevated almoſt as high as the Horſes that draw them; and the upper and under ſurfaces of this Plank muſt not be parallel to the Share, but muſt make the ſame Angle with it as its Limbers and Beam do.

Theſe Limbers ought to crook outwards from each other all the Way, 'till they come within about a Foot of the Chain, much more than the Drill Limbers need to do; becauſe the Middle of the Plank of the Drill follows directly after the Horſe, but the Middle of the Plank of the Hoe-Plow very ſeldom does; and therefore there muſt be the more

Room betwixt theſe Limbers. Likewiſe there muſt be the more Room betwixt the Fore-part of the Limbers, becauſe oftentimes the right Limber muſt be rais'd, and the left depreſs'd, in holding the Plow towards the left ſide, (for if it ſhould be held towards the right ſide, the Share would go upon the Fin, and its point be rais'd out of the Ground, unleſs it were on a ſurface that had a Declivity towards the Right). The Diſtance between the Fore-ends of theſe Limbers is two Foot eight Inches.

The ſtrength and ſtiffneſs of theſe Limbers muſt be ſuch, that there may be no bending betwixt their Fore-ends and the Tail of the Beam; for if they be too weak, ſo as to yield to the Weight of the Furrow, the Point of the Share will deſcend into the Ground and its Tail will riſe up, and then the Plow cannot go well. The ſhorter they are, the ſtronger and ſtiffer will they be, of the ſame Thickneſs. We may make them juſt of ſuch a Length, that there may be Room for the Horſe before the Bar H (which holds the Limbers at their due Diſtance). Theſe are from their ends to the Bar, four Foot ten Inches long, and from thence to the Plank ten Inches, and three Inches and a half ſquare at the Bar.

I Is the Whipper. K, L are its Notches, whereunto the Traces both of the Thiller, and of the Horſe next before him, are faſten'd. The Length of the Whipper is uncertain; but when we hoe betwixt Rows, when the Plants are grown high, we make it as ſhort as it can be, without galling the Horſe's Legs by the Traces.

We ſet this Plow to go deeper or ſhallower by the Chain of the Limbers; the changing of whoſe Links to the Crook M, has the ſame Effect as changing the Pins to different Holes of the Crow-ſtaves of a common Plow.

Fig. 2. Is the Beam with its Mortiſes and Holes; its crooking down at the Tail is not very material, but it cauſes the Hinder-ſheat to be a little the ſhorter below the Beam, whereby it may be ſomething the lighter, and yet of the ſame ſtrength as if it were longer. Its whole Length is four Foot ten Inches: We make its Breadth and Thickneſs ſuch, that it may be as light as it can be without bending. A is the Mortiſe thro' which the Hinder-ſheat paſſes. B is the Mortiſe for the Fore-ſheat, upon which it is pinn'd up. C is a Hole in the Beam, into which the end of the left Handle being driven, holds it from moving, and is the beſt Manner of faſtening this Handle of a Plow. D, E are the Holes, thro' which the two Legs of the double Retch paſs, and are there held up by their Nuts. F is the Coulter-Hole. G is the hinder Hole by which the Plow is held up to the Plank. H and I are the two foremoſt Holes of the Beam, thro' one or the other of which paſſes the Pin which holds the Beam to the fore Part of the Plank. Theſe Holes muſt be made as near together as they can be, without Danger of ſplitting them into one another; to prevent which there are ſeveral Ways: The one is by driving in two ſquare Pins croſs the Beam, under the prick'd Line *a b*, before the Holes are bored, which will prevent the Grain of the Wood from being forced out of one Hole into the other; or theſe Holes may be plated with Iron above and below, which will have the ſame Effect, and then, there need not be more than one Inch between Hole and Hole.

Fig. 3. Is the Plank a-part, which by its Holes and prick'd Lines ſhew the different Manner of placing the Beam. *a*, *a*, *a*, *a*, Are the four Holes for ſcrewing down the Limbers to the Plank.

Suppoſing the Path of the Horſe to be a ſtreight Line, and the prick'd Line *h i* (which is at right An-

Angles with the Plank, and equidiſtant from each Limber) to go exactly over it, without making any Angle on either ſide of it; then the Beam muſt be plac'd at right Angles with the Plank, to the end that the Share may go parallel to the Horſe-Path, excepting that very ſmall Inclination that its point has to the left, ſhewn by the prick'd Lines in *Fig.* 1. of *Plate* 1. But this Plow ſeldom follows the Horſe in that Manner. The ſaid prick'd Line *h i* generally makes Angles with the Horſe-Path; elſe when the Beam ſtood near the left Limber, and the Draw-Pin near the right Limber in the Hole 9. (which it muſt do to keep the Share parallel to the Horſe-Path) the Weight of the right end of the Plank and its Limber would be too heavy for the right Hand of the Holder to manage, and if the Draw-pin be removed (ſuppoſe) to the Hole 7. the Paralleliſm of the Share with the Horſe Path will be loſt, and the point of the Share may be inclin'd too much towards the left; and when a Furrow is to be plow'd on the right ſide of the Horſe-Path, the Beam muſt be remov'd nearer to the Middle of the Plank, and the Draw-pin muſt be placed on the left ſide of the Beam, ſuppoſe to the Hole 2. This will bring the greateſt part of the Plank to the right ſide of the Horſe-Path, and then the Share ſtanding at right Angles with the Plank, will make a very large Angle with the Horſe-Path, and then the Plow will not perform at all. Therefore it being neceſſary that the Share always go parallel to the Horſe-path, and often as neceſſary that the Plank go at oblique Angles to the Horſe-path; it follows then that the Beam ſtand at oblique Angles with the Plank, to preſerve the Paralleliſm to the Horſe-path, and this cannot be done but by the Holes which are ſhewn under the prick'd Lines which croſs the Plank.

The Holes A, B, C are thoſe to one of which the

Beam is ſcrew'd up by its Hole G, in *Fig.* 2. Theſe Holes are made as near to the hinder edge of the Plank, as they can ſafely be, without Danger of tearing out; which is generally about an Inch diſtant from the ſaid Edge.

Every one of theſe Holes are anſwer'd by three others, near the Fore-edge of the Plank, as the Hole B has at the Fore-edge of the Plank, the Holes D, E, F. D, E belong to the Hole I of the Beam *Fig.* 2. Theſe two Holes are made as near together as they can be without breaking into one another. F anſwers the Hole H in *Fig.* 2. and is made between D and E, as near them as ſafely it can.

When the Beam is ſcrewed up at B and F, and makes the ſame Angles with the Plank, as the prick'd Line *b c* doth; then the Draw-pin ſtanding in the Hole 8 or 9. will bring the Plow ſo much to the left, that the Share will point too much towards the right; then remove the Fore-end of the Beam to the Hole D, and then the Beam will make the ſame Angle with the Plank as the prick'd Line *c d*, which may bring the Share to be parallel to the Horſe Path nearly enough; but if the Draw-Pin ſhould be plac'd in the Hole 1. then the Plank would go ſo much on the right of the Horſe Path, that the Share would point vaſtly too much towards the left, ſtanding in either of theſe two Poſitions; therefore the foremoſt Pin muſt be removed to the Hole E, and then the Beam being at the ſame Angles with the Plank as the prick'd Line *f g*, it may be parallel to the Horſe Path, or ſo nearly, that by removing the Draw-pin one Hole, it may be made perfectly ſo.

Note, That tho' here are but nine Holes for the Draw-pin, yet we uſually make many more in our Planks, and ſometimes by changing the Draw-pin either Way into another Hole, tho' that Hole be but an Inch diſtant from the former, the Share is brought right without any Inconvenience.

The Holes A and C have each of them their oppoſite Holes which, (when the Beam is placed into either of the two) have the ſame Effect, for keeping the Share parallel to the Horſe-path, as the Hole B and its three oppoſite Holes have; and if either of the Holes belonging to A, B or C ſhould not bring the Beam ſufficiently oblique to the Plank, for the Share to be parallel to the Horſe-path, when the Draw-pin is in ſome one particular Hole, then there may be another Hole bor'd before, on the right or left, for the fore Pin to paſs through by the Hole H of the Beam *Fig.* 2. which will incline the Beam a little more to the right or left, as Occaſion requires; and if none of all theſe be ſufficient, the Plank may be turn'd the other ſide upwards, and the Beam being faſten'd there by the hinder ſcrew into any one of thoſe Holes, which were next to the Fore-edge of the Plank before it was revers'd, there may be a new Set of Holes to anſwer the fore Pin, of which that which was a hinder Hole before the Plank was revers'd, may be one. Theſe may ſet the Beam at different Angles from any of the firſt Holes; ſo that there may be at one end of the Plank ſix Syſtems of Holes, three on the one ſide, and three on the other; and if we have a Mind to make yet more various Poſitions of the Plow, we may turn the Plank, end for end, and there make ſix different Syſtems of Holes.

But inſtead of turning the Plank, it would be better to have a fourth Hole in the Beam, ſtanding as near to the hinder Hole as H doth to the fore Hole; to anſwer which fourth Hole, there may be two Holes in the Plank, one at each ſide of the hinder Hole of every Syſtem at proper Diſtances, to ſet the Plow ſtill at more different Angles with the Plank;

and theſe I believe, will be more convenient for the Purpoſe than the different Holes in the fore part of the Plank, it being eaſier to remove the hinder ſcrew than the fore ſcrew; becauſe if the Plank and Limbers are not held up by ſomebody, whilſt the fore Pin is out, their Weight will wrench out the hinder Hole of the Plank by that Screw; but whilſt the hinder Screw is out, there is no need of holding up the Plank, becauſe its Weight bearing upon the Beam, cannot injure the foremoſt Hole, whilſt the Limbers bear upon the Horſe. Upon this Account I wonder we had not made the Holes, for changing the Poſition of the Beam, at the hinder part of the Plank rather than the fore part; which convinces me that new Inſtruments are ſeldom perfect in the Beginning.

We can alſo alter the ſtanding of the Beam, by cutting away the Wood on one ſide of a Hole, and placing a Wedge on the oppoſite ſide of the Pin.

The Holder may make ſome Alteration in the going of the Plow by the Handles.

The Reaſon we never ſet the Beam on the right Half of the Plank, is that the Plow always turns its Furrow towards the right Hand; and the ſtreight ſide of the Share and the Coulter never go ſo near to a Row on the right Hand, by the breadth of two Furrows, as it does to a Row on the left Hand.

If by the drawing of the fore Horſe or Horſes, the Plow ſhould bear too hard upon the Thiller, it may be help'd by making a Row of Holes near the hinder ſide of the Plank, for the Draw-pin, inſtead of thoſe in the Middle; for the farther backwards the Draw-pin is plac'd, the leſs will the Limbers bear on the Thiller, eſpecially when drawn by more Horſes than one; becauſe the fore Horſes draw the Limbers more downwards than the Thiller doth, as may be ſeen in *Fig.* 4.

Fig. 4. Shews the Manner how the *Hoe-Plow* is drawn, and how the Traces are fix'd to it. The Traces of both Horſes are faſten'd to the Notches of the Ends of the Whipper at *a* and *b*. The Traces of the Thiller by their fore part are faſten'd to a Hook, or Ring, on the Wood of the Collar, as is uſual for other Thillers, and the fore part of the next Horſe's Traces is faſten'd to his Collar in like Manner; but theſe Traces being twice as long as thoſe of the Thiller, muſt be held up in the Middle by a piece of Cord or Chain, as at *c*, where one end of it is faſten'd to the Trace, and paſſes over the Top of the Collar, behind one of the Hames, and before the other (to keep it from ſlipping backwards or forwards) its other End is faſten'd to the oppoſite Trace on the other ſide, as this End is at *c*. This prevents the Chain from falling down, and getting under the Horſe's Legs in turning; but beware that this String or Chain be not ſo ſhort as to hold up the Traces higher than their ſtreight Line; for that would preſs upon the Collar, and gall the Thiller, beſides occaſioning the Plow to be drawn too much upwards; for this Drawing of the fore Horſe by a different Line from that of the Thiller, is a great Advantage for keeping the Plow the firmer into the Ground.

If there is another Horſe, his Traces are faſten'd at the Collar of the ſecond, in the ſame Manner as in drawing of a Waggon.

When we hoe betwixt Rows where the Plants are very high, as thoſe of Turnep-Seed, which are much higher than the Horſes, to turn a new Furrow up to the Row, when there is a Trench in the Middle of the Interval, where the Horſes muſt go, we find it beſt to place the Beam by the Holes B and E, in *Fig.* 3. and the Draw-pin near the left Limber, which brings the Tail of the Plow to the right Hand, and the fore Ends of the Limbers being towards the left, the End of the right Limber (by turning the Handles a little to the left), bears againſt the wooden Saddle at *d*, and cannot hitch into or take hold of any of the Plants to tear them. And that no part of the Limber may take hold of any Plant, we make it very ſmooth from one End to the other, and cut off the Corner of the Plank equal with the Limber, that the Plants may ſlip by it without hanging in it, or being broken by it. The Whipper ſtanding towards the left End of the Plank, its End *b* does not reach ſo far towards the right as to take hold of the Plants, its End *a*, being over the Interval where no Plants are; and to keep its right End the more out of Danger of hurting the Plants, we place the Hook of its Chain nearer towards this End, by which Means the left End, becoming heavier, ſinks lower, and raiſes the right End higher, and the higher it is, the more ſecure the Plants will be from it; becauſe they are held off by the Limber above.

This Way my Turnep-Seed has been hoed, when one would have thought it impoſſible for a Plow and Horſes to go betwixt the Rows without deſtroying the Crop. Almoſt in this Manner we give our Wheat the laſt Hoeing, to turn the Furrow a ſecond Time towards the Row. When the Plants of the Rows are very high, the Driver muſt go in the next Interval, on the left of the Plow, and the Holder has a Cord, like the Reins of a Bridle, which he lays over the End of the Draw-pin, which keeps it from falling down, until he has Occaſion to uſe it for Guiding or Turning the Thiller.

When we turn the Furrow from the Row, (which will then be ever on the left ſide of the Plow) the Plow muſt be ſet in a very different and contrary Poſture; but then the Plants commonly being low, there is no Danger of the Whipper's or Limber's hitching or taking hold of them; but the Driver muſt take Care that he does not tread on them, nor ſuffer any of the Horſes to do ſo, and they of themſelves when they are not blind take all the Care they can to avoid it; and I obſerve that the Plants are oftner injur'd by the Driver, than by the Horſes.

'Tis in this laſt mention'd Manner of Hoeing, when we go very near to the young Plants, the firſt or ſecond Time, that we muſt take Care of burying them with the Earth, which (eſpecially) when dry and fine is apt to run over to the left ſide of the Plow; this we can in great Meaſure prevent, when the Ground is clean, by nailing with three or four Nails a very thin ſquare piece of Board to the Sheat, with one Corner bearing at or below *a*, in *Fig.* 1. and its other lower Corner bearing on the Back of the Coulter on its left ſide at *b*, its upper Corner reaching to *c*, or higher; its fore End is ty'd on to the Coulter by a leathern Thong paſſing thro' a Hole very near the End of the Board, the lower Edge of the Beam muſt come no lower than the prick'd Line *a b*, which is juſt even with the Surface of the Ground before it is rais'd by the Share; for if this Board ſhould be ſet down too near the Share, the Plow would not go; but being ſet in this Manner, it prevents the Earth (when never ſo much pulveriz'd in the drieſt Weather) from running over upon the Plants to bury them tho' the Plow go very near them; except in this Caſe we never uſe a Board, the Earth running over to the left ſide, being often advantageous in Hoeing; for it changes more Surface of the Ground, than if it went all to the right, and when in Summer we Hoe *from* the Wheat Rows, not going very near to the grown Plants, this Earth that runs over the Share to the left, helps to mend ſuch Places where the Furrow was not thrown up cloſe enough to the Row by the precedent Hoeing.

The firſt Time we turn a Furrow *towards* the Row, the Horſes go in the Trench near to it, and the Plow ſtands on the left ſide of the Horſe-path, almoſt in the ſame Manner as when the Furrow is firſt turn'd from the Row; but we very often make Uſe of a common Plow, for throwing down the Ridge which has lain all the Winter in the Middle of the Interval. One Wheel going on each ſide of that Ridge, holds that Plow to a great Exactneſs for ſpliting this Ridge into Halves, which the Earth-board, being ſet out for that Purpoſe, throws up to the Row on each ſide of the Interval.

We alſo very often make Uſe of the two-wheel'd Plow, for raiſing up the Ridges, whereon we drill the Rows; not but that the Hoe-Plow will do every thing that is neceſſary to our Husbandry, yet the common Plows being heavier than we uſually make our Hoe-Plows, they by their Weight and Help of their Wheels go a little ſteadier, and beſides the Plowmen being more accuſtom'd to them prefer them before all other, where their Wheels are of no Prejudice.

I never ſaw neater Ridges rais'd by any Plow, than by the Hoe-plow, nor finer plowing; and I believe that were it made as heavy and as ſtrong, it would outdo the *Swing-Plow*, in plowing miry Clays, where Plow Wheels cannot go; but I having no ſuch Land, have never made any *Hoe-Plow* heavy enough for it. However I am convinc'd, by the many Trials which I have ſeen, that no other Plow can be uſed for every Horſe-Hoeing Operation, ſo effectually as this I have now deſcrib'd.

The making the *Hoe-Plow* is not difficult for a good Workman; and a few of the Holes for ſetting the Beam are ſufficient, provided they are made in their proper Places, which is impoſſible for me to deſcribe exactly in a Number that is no more than ne-

neceſſary; becauſe the Diſtance the Plow muſt go from the Horſe-path on either ſide, is uncertain, as the Largeneſs or the Depth of the Furrow is; and for that Reaſon, 'tis as impoſſible for me to direct the Plowman to the particular Angles, at which his Beam muſt be ſet with the Plank, to keep the Share parallel to the Horſe-path, as it is to direct a Fidler, how far he muſt turn his Pegs to give his Strings their due Tenſion, for bringing them all in Tune, which without a Peg to each String could never be done; but when he has his juſt Number of Pegs, his Ear will direct him in turning them, 'till his Fiddle is in Tune; ſo the Plowman by his Eyes, his Feeling, and his Reaſon, muſt be directed in the ſetting his Plow; but without a competent Number of Holes, he can no more do it than a Muſician can tune four Strings upon one Peg. And I am told that ſome Pretenders to making the *Hoe-Plow*, have fix'd its Beam to the plank immoveable, which makes it as uſeleſs for hoeing betwixt Rows, as a Violin with but one Peg to its four Strings, would be for playing a *Sonata*.

Fig. 5. Shews the ſort of Yoke, that is us'd on every Ox that draws in a ſingle File, as they always muſt when they work with the *Hoe-Plow*; but after they have been accuſtom'd to draw double (*i.e.* two a-breaſt) they muſt be practis'd for about a Week to draw ſingle, before they are ſet to hoeing; for otherwiſe they will be apt to demoliſh the Rows, one running off to the right Hand, expecting his Fellow to come up with him on the left, and another will run off on the left to make Room for his Companion to go a-breaſt with him on the right, endeavouring to go in the Manner in which they us'd to be placed for drawing in Pairs.

I ſuppoſe I need not give any Caution about muzzling the Oxen when they hoe; becauſe they will eat the Plants as ſoon as they come an Inch above the Ground, and that will ſhew the Neceſſity of it; but there is no Occaſion to muzzle the Horſes until the Plants are grown as high as their Noſes, when rein'd up as in *Fig.* 4.

Fig. 6. Is an Inſtrument of Pulveration, which might have been ſufficiently deſcrib'd by its Matter, Weight, and Dimenſions, without any Portrait, were it not to ſhew the particular Manner of drawing it, being very different from that of a common Roller, whoſe Frame is difficult to make, and coſtly; but this being only three Foot long, is drawn by a ſimple pair of Limbers, held together by the two Bars A and B, firmly pinn'd in at their Ends.

Its Gudgeons muſt not come out beyond the outer Surface of the Limbers, leſt they ſhould take hold of the Plants, when drawn in the Intervals; alſo the hinder Ends of the Limbers, behind the Gudgeon, ſhould crook a little upwards, for the ſame Reaſon.

This Stone Cylinder is two Foot and a half Diameter, and weighs eleven hundred Weight beſides the Limbers. It muſt never be us'd but in the drieſt Weather, when neither the Plow nor Harrow can break the Clods; and then being ſo very ponderous and ſhort, it cruſhes them to Powder, or into ſuch very ſmall pieces, that a very little Rain, or even the Dews (if plentiful) will diſſolve them.

I have had great Benefit by this Roller in preparing my Ridges for Turneps. The Weather proving dry at Midſummer (which is the beſt Seaſon for planting them) the Land was in pieces like Horſe-Heads, ſo that there was no Hopes of reducing them fit for planting with Turneps that Year; the Clods being ſo very large, that they would require ſo many Viciſſitudes of wet and dry Weather to ſlack them; but this Inſtrument cruſh'd them ſmall, and the Plow following it immediately, the Ridges were harrow'd and drill'd with very good Succeſs.

I have alſo made uſe of it for the ſame purpoſe in the Middle of a cloddy Field, where it pulveriz'd the Clods ſo effectually, that the Benefit of it might be plainly diſtinguiſh'd by the Colour and Strength of the two following Crops, different from the other parts of the Field adjoining on both ſides, whereon the Roller was not drawn.

But cruſhing has ſuch a contrary Effect from ſqueezing, that if this Roller ſhould be us'd when the Land is moiſt, it would be very pernicious, by unpulverizing it, of which I am ſo cautious, that ſometimes I let the Roller lie ſtill for a whole Year together.

There is alſo a long triangular Harrow, which is ſometimes uſeful in the Intervals when the Earth is of a right Temper between wet and dry; but there is no need to deſcribe it, and I ſcarce uſe it once in two or three Years.

The Diameters of the wooden and Iron Pins and Screws, with their Holes, and the Sizes of the Nails to be made uſe of in all the deſcrib'd Inſtruments, I leave to the Diſcretion of the Workmen, who, if they are Maſters of their ſeveral Trades, cannot be ignorant of ſuch Matters.

Fig. 7. and *Fig.* 8. Shew the Lands of Turneps mention'd in *Pages* 1 and 2.

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I Should acknowledge that all the *Engliſh* Verſes in the IXth Chapter were tranſcrib'd from an anonymous Tranſlator; I choſe to make uſe of theſe, becauſe I thought they came *nearer* to *Virgil's Meaning* than any other Tranſlation I had ſeen.

Note, The Length of a common Plow-Share's Neck, does not always bear ſo great a Proportion to its other Parts, as of that in *Fig.* 1. of *Plate* 1. but very often the ſame as that of *Fig.* 2. and the other Shares ſhewn in the ſaid *Plate.*

The Plow-Wright in placing the Sheat into theſe Plows, ought to obſerve the *Obliquity* of it deſcrib'd in *Fig.* 4. (the fore End of the long Handle X. and of the Earth-Board nearly conforming thereto) which *Obliquity* is greater than it ſeems to appear in the *Perſpective* View of it in the Plow *Fig.* 3.

He muſt not work by that *Perſpective* in *Fig.* 1. which makes the long Handle X ſeem *crooked* tho' it is ſtreight as in *Fig.* 13.

Note likewiſe, There might be perhaps ſome Ounces of Braſs *ſaved* in caſting the large Seed-Box, if its hinder Part were caſt *thinner*, except where the Screw goes thorough it to hold the two Halves together.

Note alſo. The Drill-Sheats in *Plate* 4. muſt be *tapering downwards*, ſo that they may not be *thicker* in that Part that goes *within* the Ground, than the Breadth of the Share.

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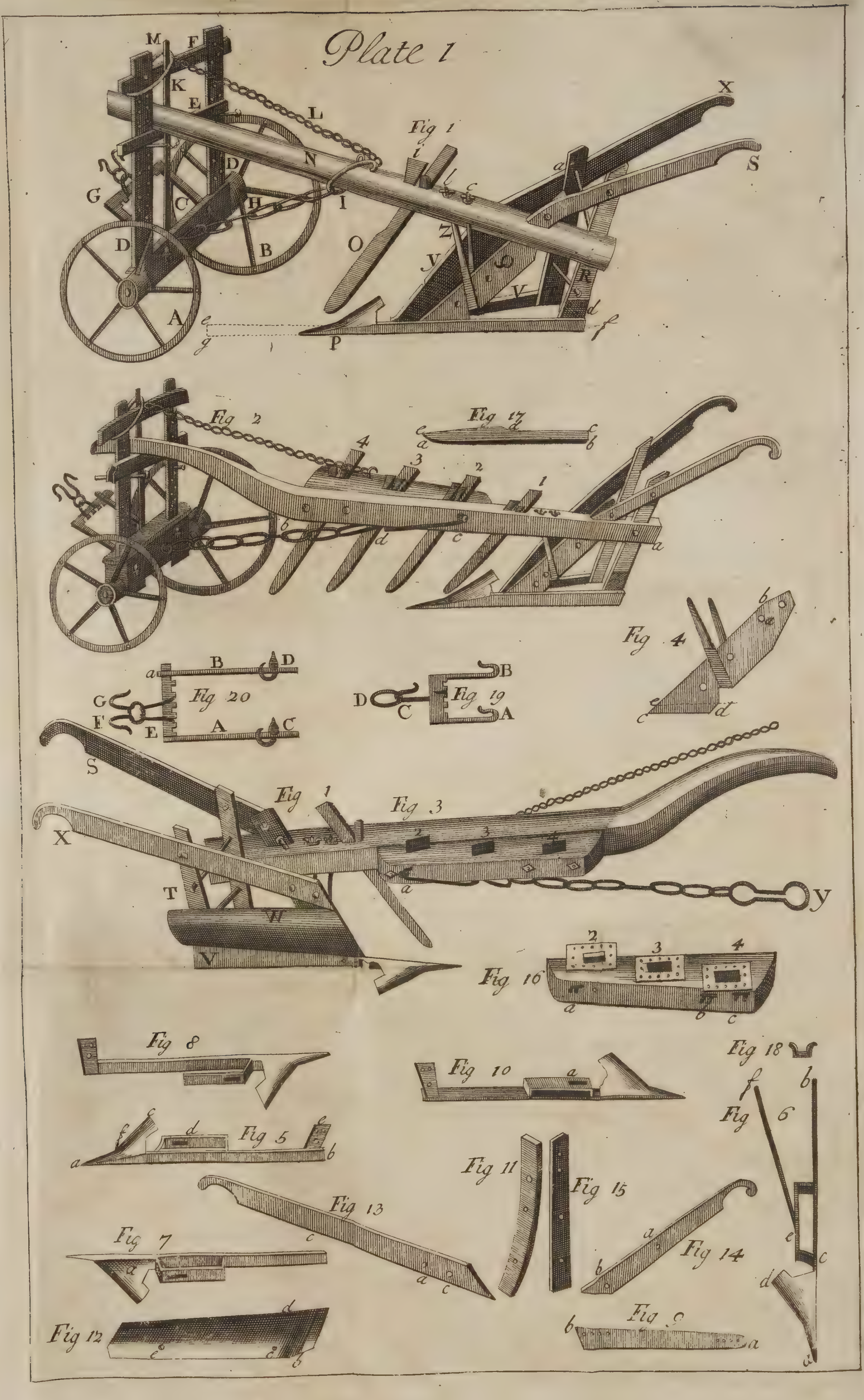
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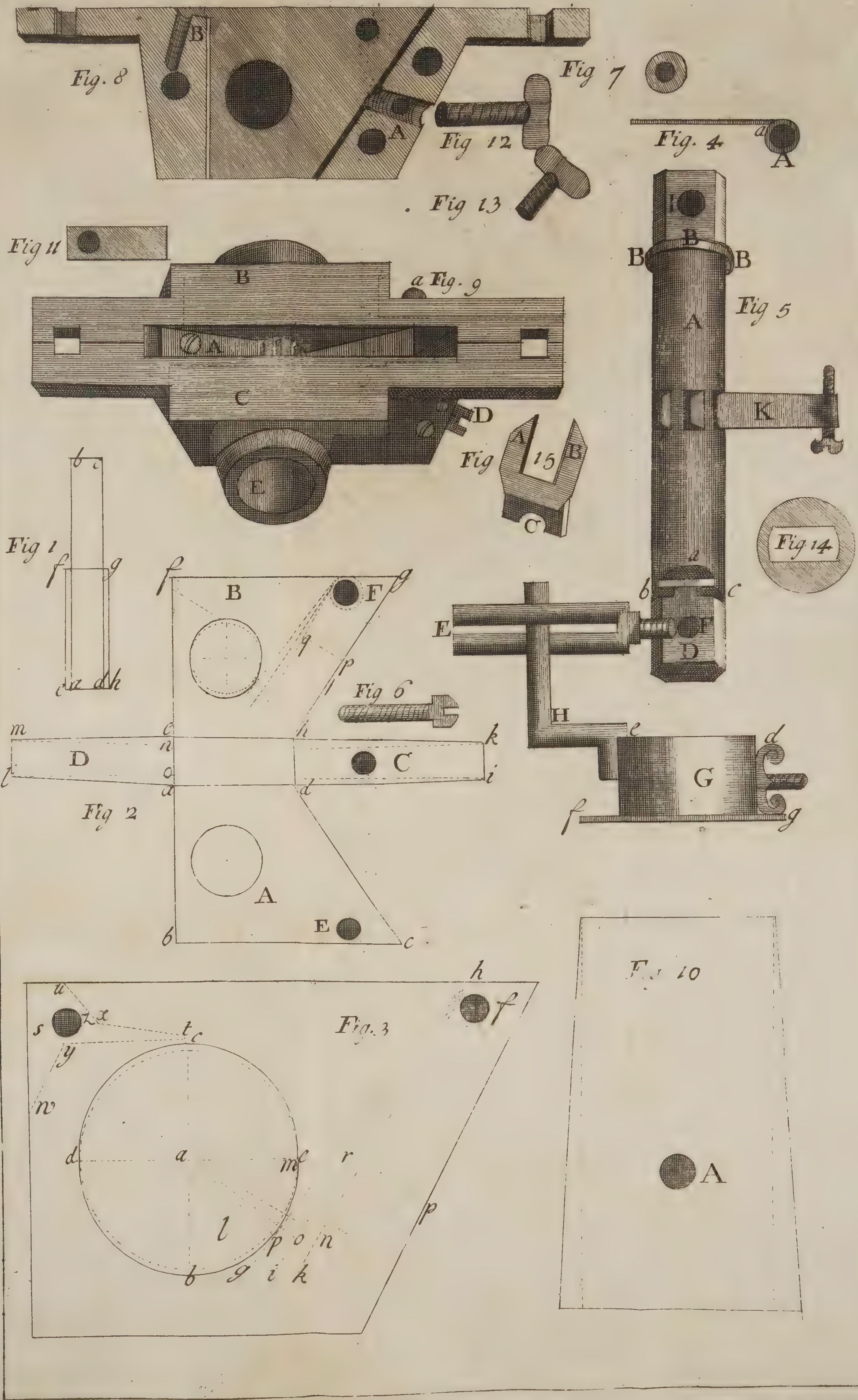
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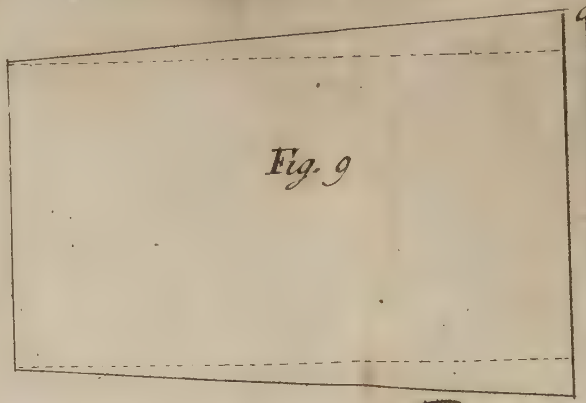

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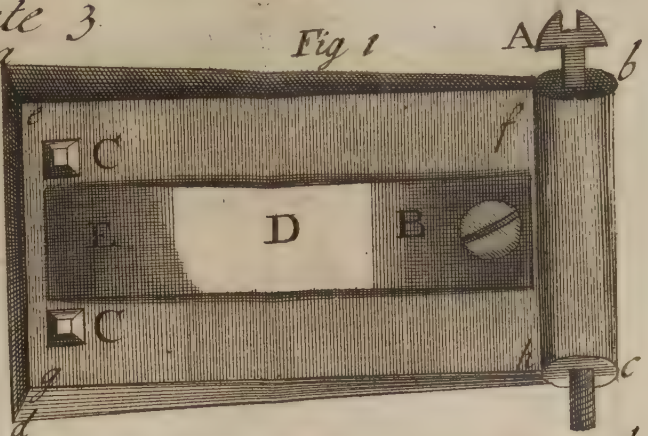

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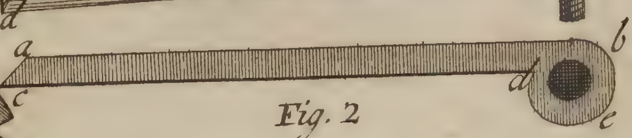

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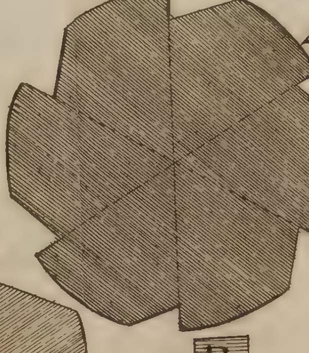

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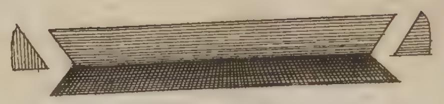

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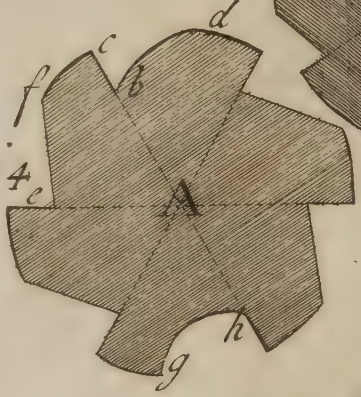

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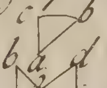

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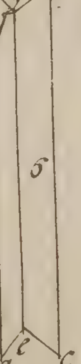

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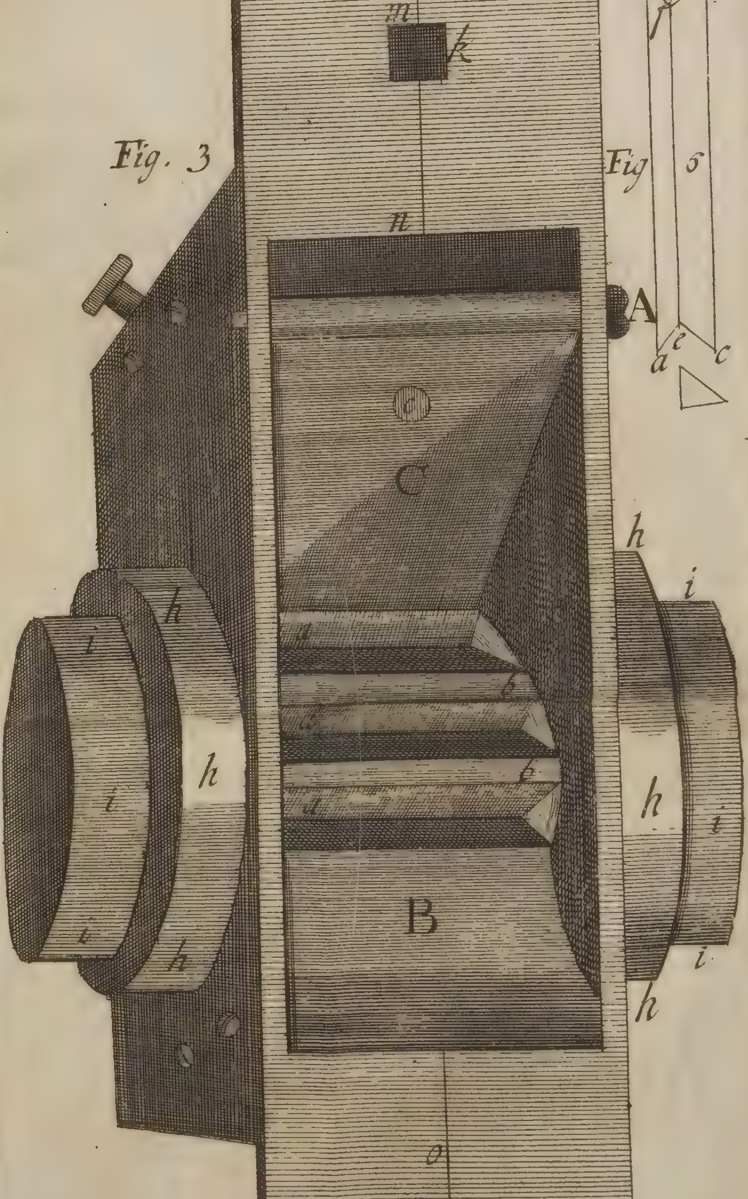

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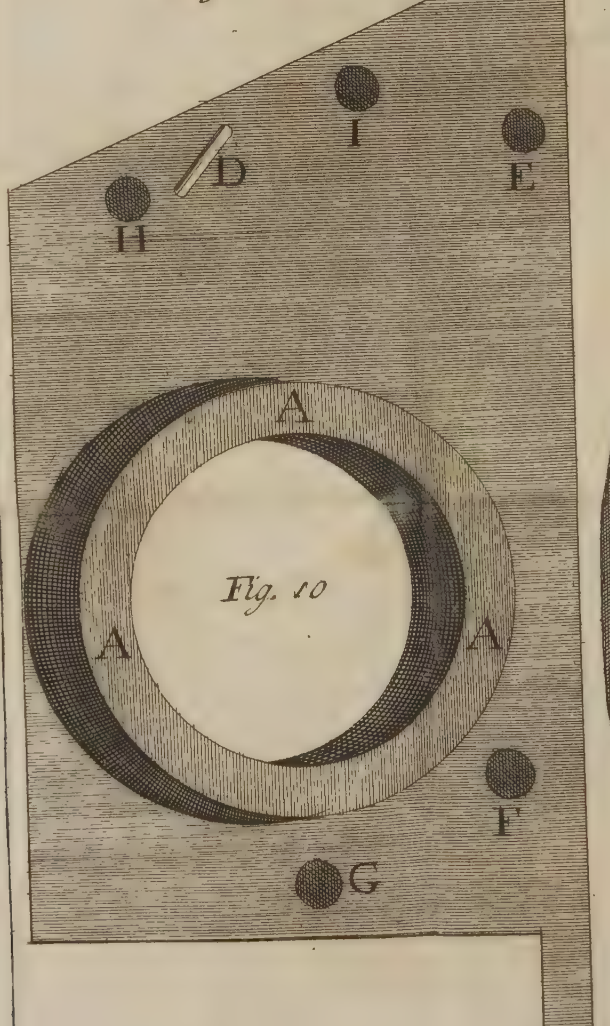

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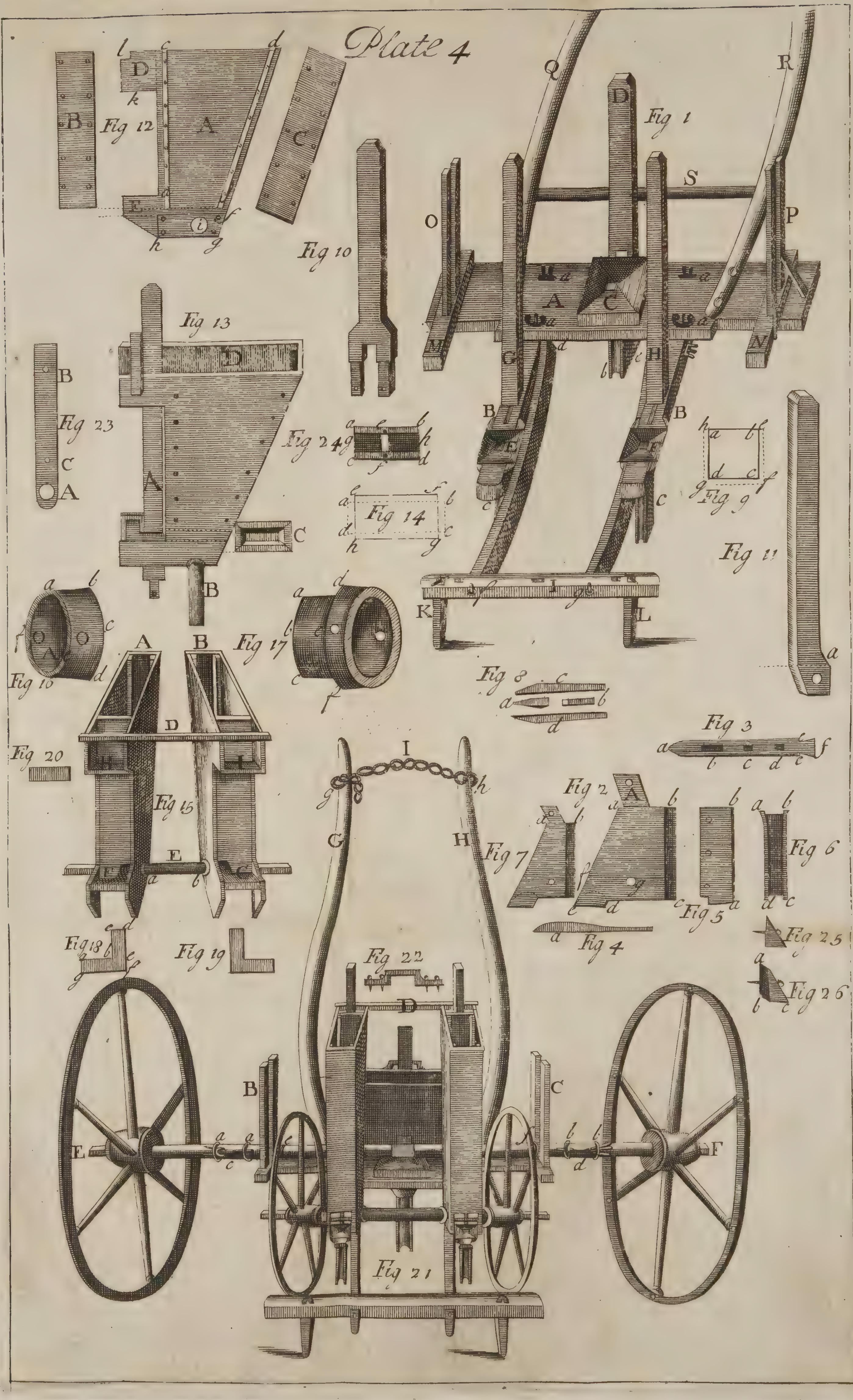
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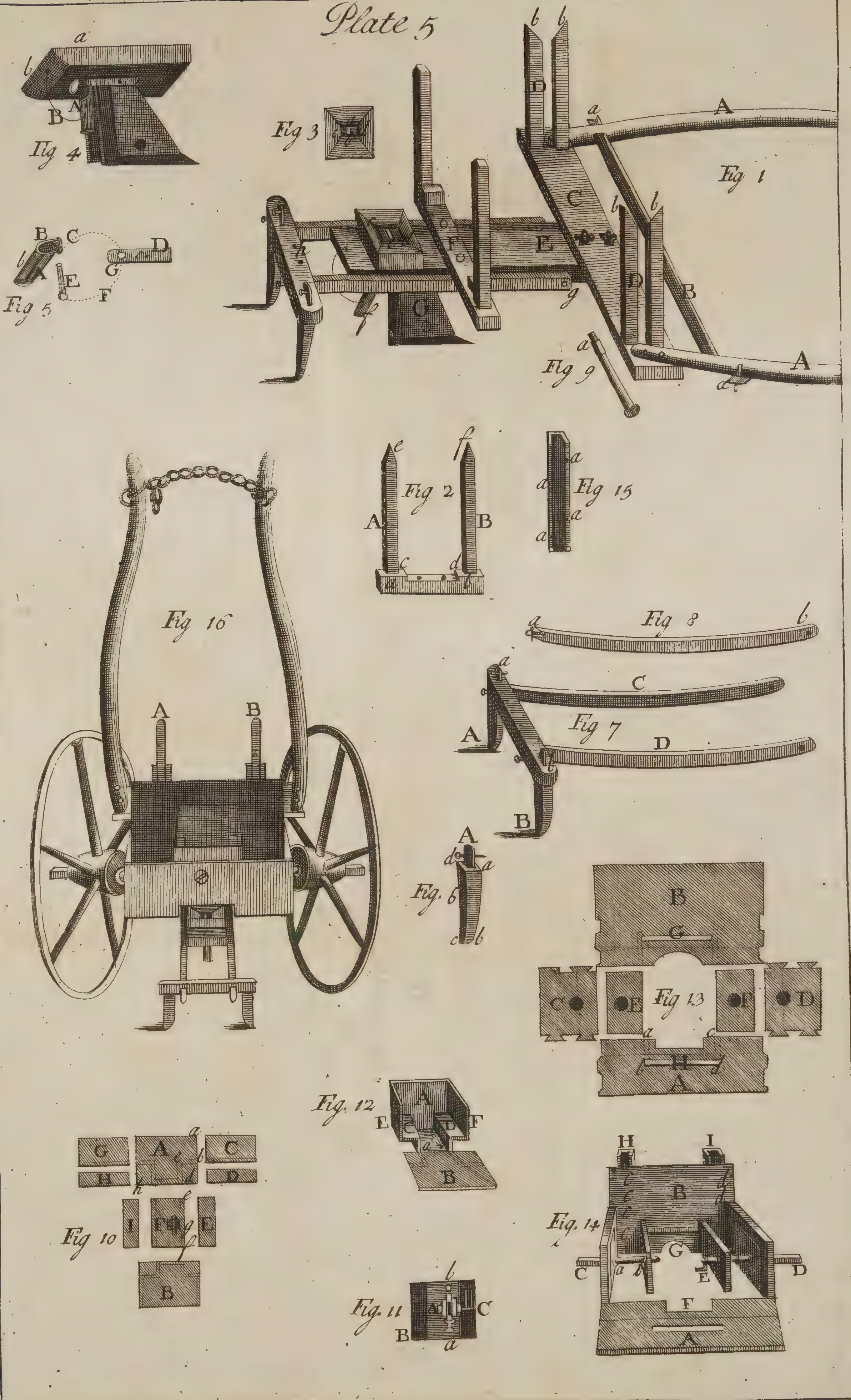
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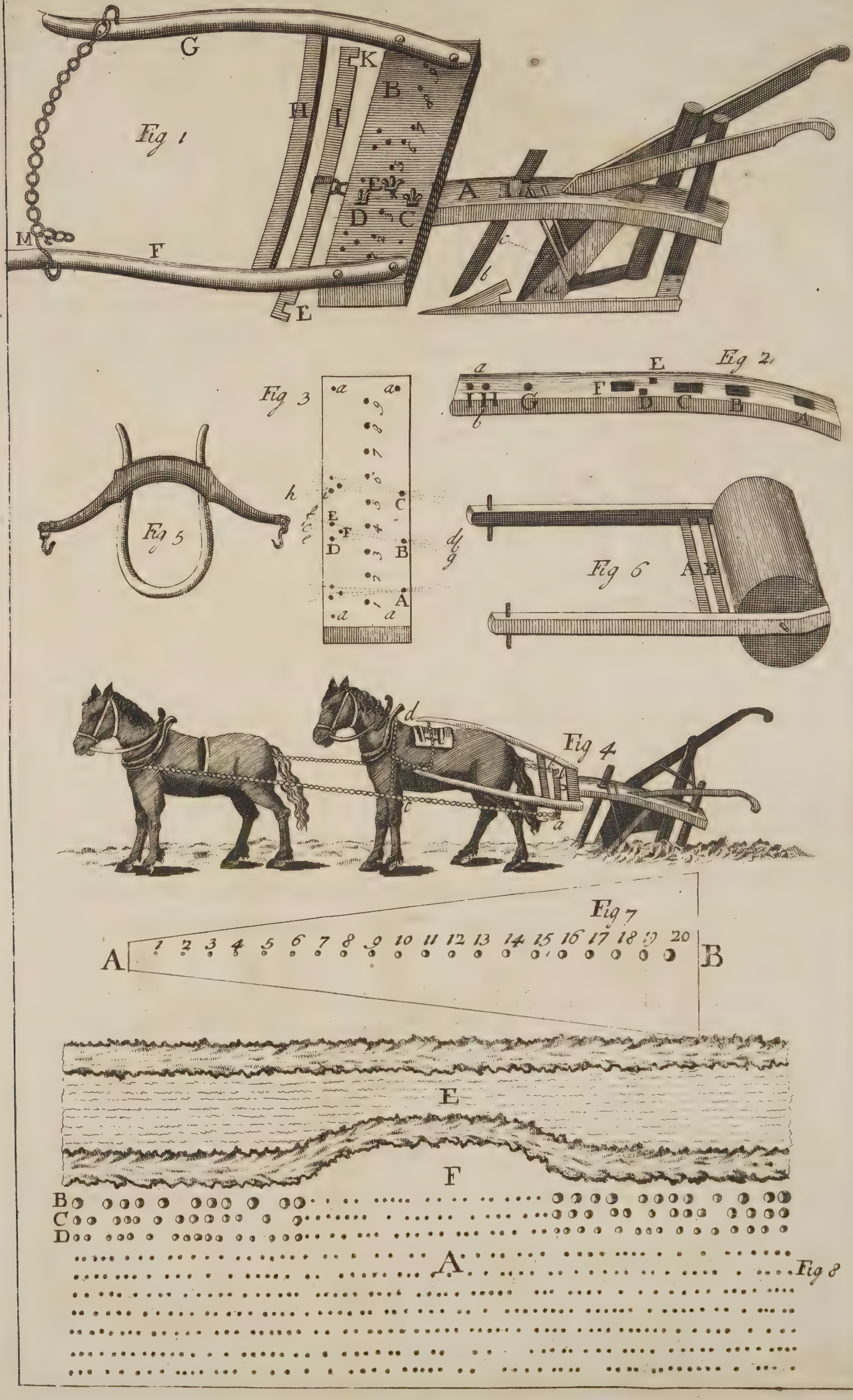

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